OCT 15 1947

Electrical Construction and Maintenance

ELECTRICAL CONTRACTING

PLANNED LIGHTING

Layout and Design Data

A 28 page manual of useful data for lighting system application – in this issue.

OCTOBER · 1947

A McGRAW-HILL PUBLICATION

PRICES REDUCED...

on most

G-E CIRCLINE BALLASTS

Prices on General Electric's famous Circline ballasts have been reduced as much as 20 per cent. The table below shows where these reductions have been made and their extent. Stepped up production and more efficient manufacturing tools have made these reductions possible.

Ballasts are available for both the 12-inch, 32-watt and the 8¼-inch, 22-watt Circline lamps. They are designed in uncorrected or high-power-factor ratings for single lamps, and for high-power-factor Tulamp operation. Ballasts are made in rectangular design, and in the disk-shape design which lends itself to mounting in the base of a lamp or to concealment in shallow wall or ceiling fixtures. Bulletin GEA-3293 gives full details, wiring diagrams and dimensions. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

New list prices on single-lamp and Tulamp ballasts for Circline lamps. 60 cycles, 110-125 volts

Lamp Diameter	Lamp Watts	Ballast Cat. No.	Type	Approx Power Factor	OLD List Price Each	NEW List Price Each
12"	32	59G440	Single-lamp rectangular case	50	$2.75	$2.50
12"	32	59G420	Single-lamp circular case	50	3.25	2.50
12"	32	59G425	Single-lamp circular case	90	6.00	4.75
12"–12"	32–32	59G442	Tulamp rectangular case	95	*	6.00
12"–12"	32–32	59G424	Tulamp circular case	95	7.50	6.00
12"– 8¼"	32–22	59G443	Tulamp rectangular case	95	*	6.00
12"– 8¼"	32–22	59G429	Tulamp circular case	95	7.00	6.00
8¼"	22	59G419	Single-lamp rectangular case	50	.90	.90
8¼"	22	59G428	Single-lamp rectangular case	90	3.50	3.50

** These are new designs, not previously listed.*

TWO NEW CIRCLINE BALLASTS, TOO

General Electric announces two new Tulamp ballasts for Circline lamps. Both are of conventional design and will find the greatest use in ceiling fixtures and other general lighting applications. Catalog No. 59G442 operates two 12-inch, 32-watt Circline lamps; Catalog No. 59G443 operates one 8¼-inch, 22-watt lamp and one 12-inch, 32-watt lamp.

GENERAL ELECTRIC

412-12

Electrical Construction and Maintenance

With which is consolidated Electrical Contracting, The Electragist and Electrical Record...Established 1901

A practical technical and management journal for electrical contractors, industrial electricians, inspectors, engineers and motor shops, covering engineering installations, repairing, maintenance and management, in the field of electrical construction and maintenance.

October • 1947

October—at a glance 41

Essential to Production 43

NECA Convention Report 45
A report of the annual meeting of the National Electrical Contractors Association.

Escalator Installation 50
By HUGH P. SCOTT—Photocell controls, multiple safety devices and modern lighting are features of new high-capacity moving stairway installation in a department store.

Volume-Duration Studies 52
By RAY ASHLEY—A discussion of contractor's limitations and the "one-third volume" rule.

Planned Lighting Design and Layout Data—*A Feature Section* 57
A 28 page manual of useful data for lighting system application.

Industrial Electrification 149
The Use of Capacitors in Industrial Plants—Part I

Departments

Practical Methods 135
Equipment News 139
Reader's Quiz 154
Questions on the Code 169
Motor Shops 179
In the News 185
Advertisers' Index 216

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OCTOBER . . . . *at a Glance*

Los Angeles Lighting

The Southwest has taken its share of kidding about its unbelievable weather and fantastic ideas. But nowhere in the world has there been more dramatic and skillful use of modern commercial lighting. Los Angeles and its surroundings are studded with shopping centers and commercial areas where planned lighting techniques are employed in infinite variety. Part of it is caused by the presence of many top flight industrial designers in the area. Much of it is due to a native daring in the use of modern materials and techniques. Like modern lighting everywhere, it is highly contagious. Entire blocks of shops and stores have gone all out in modernizing with planned lighting. The lighting industry has much to learn from this vibrant, growing community. If you are inclined to be conservative about the potential lighting market take a trip to L. A.

Fire the Laggards

In a somewhat erudite discussion of labor productivity, one unreconstructed rebel threw in some first principles, "Fire the laggards and establish some decent job discipline." It sounds drastic in these times. But it was backed by straight-thinking wisdom. "We need men so badly we hire anybody with a pair of pliers and a card. What are we doing to the morale of our good men? They work beside these characters for the same pay, the same hours, the same working conditions and the same security. They want to do a decent day's work. They are proud of their craft. If we don't have the back-bone to put the bums on the street, how can we hope to get productivity or the respect and confidence of good mechanics?" Drastic counsel, in these days of labor shortage, but sound.

REA Construction

The time will come when REA contracts will return to labor and material. When depends on the supply of the still critical items like transformers. So says J. K. O'Shanguessy in speaking before NECA contractors last month in San Francisco. Since May 1946, much of the REA line program has operated under "Memorandum No. 170" which provides for handling construction on a labor only basis. A good many arguments have been offered to support this procedure in these times. Actually, the most important is that it gives the co-op a chance to buy materials long before it has to tip its hand by letting out staking sheets. The whole REA program is too important to be tied up in clever procedures. Let's hope that we can go back quickly to normal contracting with materials flowing through regular industry channels. In the long run someone has to carry the costs that are "saved" by special contracting techniques.

Connectors

During the war millions of multiple contact connectors were produced for radio, radar and aviation electrical apparatus. Complex equipment could be removed, tested and replaced without disturbing the wiring system. Research, development and engineering produced connectors of excellent reliability and a high order of precision that give trouble free service on elaborate apparatus. In conventional electrical work, however, beyond a few standard plugs and receptacles there is still comparatively little application of the multiple contact connector. Its practical possibilities deserve at best a tryout, particularly on control apparatus and circuits. Very often maintenance of electrical equipment must be handled in inconvenient or dangerous surroundings. With connectors the whole apparatus could be quickly removed and replaced. The placement of apparatus is often a compromise between convenience to the operator and convenience to the maintenance man. Connectors could readily solve many such problems.

Installed Prices

One of the most persistent complaints heard around electrical circles these days is about installation prices. A "good" price on a range or dryer or some other equipment that takes skilled installation doesn't mean very much because installation costs vary all over the scale. They seem to be completely unpredictable. It is a legitimate squawk. We know that such jobs actually do have a wide cost range and in most cases the variations are entirely understandable to anyone in the contracting business. That, however, is our problem. It is not one that we can conscientiously unload onto the manufacturers or dealers of appliances and equipment. Electrical contractors can and should take the initiative to establish flat rate community-wide installation services on major appliances, high enough to carry the average job and as low as possible consistent with a fair return. Appliance sales are a major influence on the market for wiring. The market potential is big enough to justify a considerable business risk. Actually the risk is negligible. Most Combined industry experience would provide a constant check on theflat rates. They could be adjusted periodically. In the meantime, sales efforts could forge ahead with firm, rational and understandable prices.

Electric Heat

On the West Coast electric space heating is growing at an almost uncontrollable rate. While electric heat may be more "expensive" than fuels, moderate climate and cheap power makes the total cost difference a minor problem. The convenience, safety and unlimited adaptability of electric heat are far more compelling considerations. Most significant, however, in this development is the revolutionary point of view. In many of the new buildings and homes electric heating is the first method considered. Fuels are in the peculiar and awkward position of having to be sold against electric heat, with electric heat in a dominant position of public acceptance. Some of the lessons learned there may have nation-wide reactions. There is no reason why the bathroom heater cannot become as conventional as the bathtub, whatever kind of central heating is employed. And electric panel heating, which offers a new order of comfort, may be entirely practical in more vigorous climates.

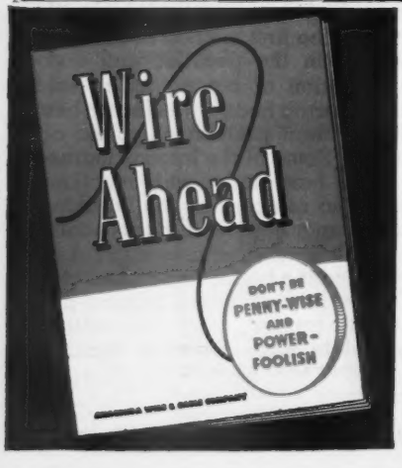
Arrest this Thief!

Because adequate wiring is basic ... and affects everyone in our industry ... Anaconda continues to promote this idea in a wide list of national magazines.

INADEQUATE WIRING, the industrial jinx, can rob any plant large or small . . . of as much as 25 to 50 percent of rated efficiency. And what's most discouraging, the greater the production load, the deeper he digs into your resources.

Obsolete, overextended, overtaxed wiring may be difficult to detect, but it's too expensive to ignore. You may not be able to see this demon, but your plant power engineer, your consulting engineer, electrical contractor, or utility power salesman *can*. A little policing now may save expensive alterations later.*

47449



*WIRE AHEAD, a new booklet discussing preventive maintenance . . . the symptoms of inadequate wiring . . . and presenting plans for anticipating electrical demand, is now available on request. Address Advertising Department, 25 Broadway, New York 4, N.Y.

ANACONDA

ANACONDA WIRE AND CABLE COMPANY

ESSENTIAL TO PRODUCTION

ELECTRICAL MAINTENANCE and repair work is rarely spectacular. Much of it is a routine preventive operation. Wiring systems, motors, controls, signals and lighting equipment are inspected, cleaned, lubricated and adjusted to avoid shutdown or major repairs. When breakdowns happen, there is a crew of skilled mechanics on hand within a few minutes, spare equipment is hooked up, production is restored while the machinery of the maintenance department, the industrial electrical contractor or the motor repair shop quietly expedites permanent repair or replacement.

IN SOME OF OUR highly integrated mass production plants, where shutdowns in one department can affect the total plant output, electrical repairs take place in minutes with fire department speed and organization. Over the whole country there are very few places where electrical apparatus cannot be repaired or replaced within a few hours. We take all this for granted. American commerce and industry use a vast amount of electrical mechanism. Naturally, service organizations would grow around them.

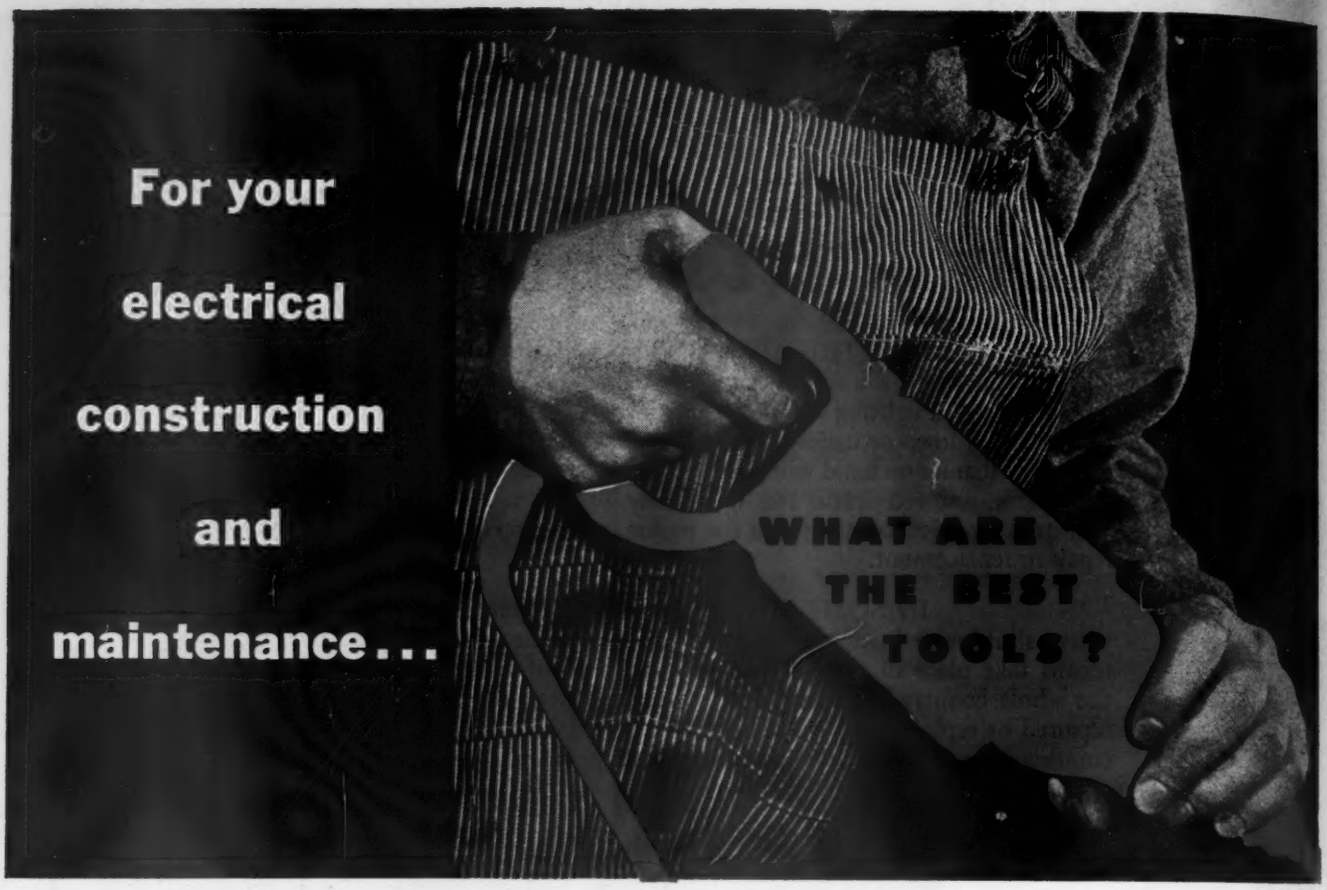
BUT THERE IS another facet of great importance that we rarely consider. Industry and commerce can use and apply electrical apparatus to their operations only because there are competent maintenance and repair facilities "in being" and ready to serve. These facilities are a vital part of our production resources and an essential of commercial operation. A modern factory could operate for only a few hours, a department store or office building for only a few days without electrical maintenance before they would be bogged down by their own complex electrification.

AN AMERICAN ENGINEER returning from Russia described acres of fine machines, in orderly and efficient layout, lying idle for want of minor parts, repairs or electrical connections. The designing engineers had copied our efficient production mechanisms with inspired accuracy. They had missed the complex network of service facilities which are such a normal part of our own industrial communities that even we rarely think of them as an essential part of our great industrial productivity.

IT IS ONLY WHEN MAINTENANCE and repair facilities are absent as in primitive lands or industrially backward countries that their complex structure becomes clear. The skilled mechanic brings to bear years of experience and ingenuity. Behind him is specialized management skill and foresight that provides the pool of skilled manpower and resources where and when they are needed. Established lines of distribution bring needed materials from convenient stocks or special parts by air express from distant factories. Foresight in equipment design provides for quick and easy repair and replacement. Such facilities are not created over night. They have evolved with electrification.

THE VITAL ROLE of maintenance in the modern electrical scene could never have grown without responsibility and initiative. Public confidence in electrical apparatus and equipment can be created or killed by the men who keep them running. It is a constant challenge. In the years ahead the growth of the whole electrical industry will be critically affected by the caliber of men, methods and management we bring into the field of maintenance and repair.

Wm. F. Stuart



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NECA Convention Report

SAN FRANCISCO SEPTEMBER 8-10

The need for greater production, lower construction costs, and aggressive selling were discussed by leaders of the major branches of the electrical industry and the public during the annual meeting of the National Electrical Contractors Association. J. Walter Collins received the James H. McGraw Award.

In a resolution demanding from its suppliers firm prices on materials for specific jobs and definite delivery schedules of the material to the job, NECA branded the escalator clause as the certain road to more inflation. This action came after a three day meeting of the National Electrical Contractors Association in San Francisco, which was concerned entirely with discussions of the costs of production and means of getting those costs down, or at least stabilized, so that building can go forward to meet the huge construction demand of the country.

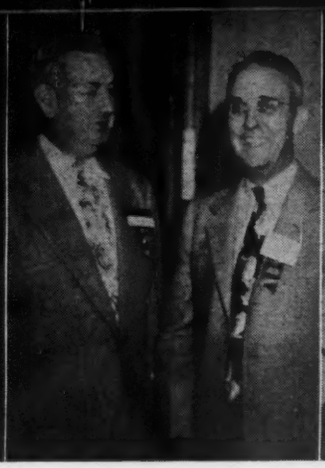
In another resolution having to do with the reduction of building costs, the Convention adopted the recommendation of its Interdependence Committee that the industry point out to the buyers of electrical construction that the most economic way is that which permis maximum coordination of materials and labor on the job. The resolution points out the high cost and unsatisfactory nature of installation—only electrical construction.

More than 750 electrical contractors from all parts of the United States attended the 46th annual convention of the National Electrical Contractors Association at the Palace Hotel. An industry-wide review of the cost of electrical installations and an analysis of the problems affecting the production of the electrical construction industry were made. Viewpoints, criticisms and suggestions were presented by representatives from all branches within the electrical industry and the public.

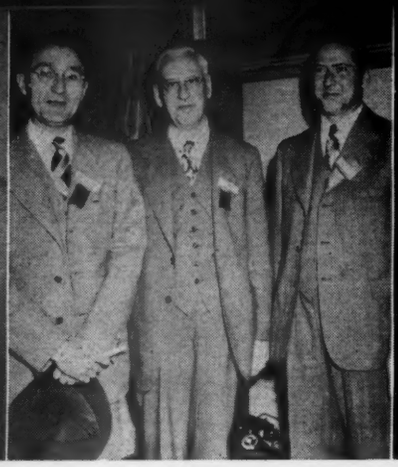
Robert W. McChesney, president of NECA, presided at the opening meeting. Addresses of welcome were presented by Rodger Lapham, Mayor of San Francisco, officers of NECA and representatives of IBEW. Reports were given by Paul M. Geary, executive vice president, Clint J. Harder, secretary and L. W. Davis, treasurer.

Firm prices, definite deliveries, lower taxes and aggressive selling are ingredients necessary for lower construction costs, which are vital to sustaining the American free economy, Robert W. McChesney, said in his opening address.

Geo. W. Abbett, Abbett Electric Co., San Francisco and R. W. McChesney, president, NECA and Harry Alexander, Inc., Washington, D. C.



George W. Patterson, Patterson Electric Ltd., Toronto, Canada and K. D. White, White Electric Construction Co., Atlanta, Ga.



W. F. McCarter, Cates & Shepard; Harry B. Frazer and W. Edward Frazer, H. B. Frazer & Co., all of Philadelphia.

A. Lincoln Bush, Belmont Electric Co., Inc., New York; Leo E. Mayer, Hyland Electric Supply Co., Chicago; and T. L. Rosenberg, T. L. Rosenberg Co., Oakland, Calif.

Mr. McChesney was optimistic about the electrical construction industry's future. He foresaw demand requiring full-scale activity by the industry for the next ten years.

We can carry out high employment and high wages only if we can make the price attractive to the purchaser, he said. Big backlog means nothing unless the buyer is willing. We must all work to make the price one which will attract the buyer, being content, if necessary, with a lower ratio of profits and possibly a lower wage unless means can be found to make that wage pay its way production-wise.

The next big step for NECA is in the direction of distribution; the merchandising of electrical materials and equipment by the contractor who in recent years has concentrated on the engineering and installation aspects of building.

The installation-only type of business has become all too frequent. The fastest and most economical way to get an electrical installation is by purchasing the complete job, both labor and materials, from the electrical contractor.

Another way to reduce electrical construction costs is through standardization and simplification and he urged manufacturers to act immediately to reduce the number and sizes of materials and equipment that served no really useful purpose.

The nation's economy can come down without injury from the plateau of feverish production to a lower and normal level of output, Dunlap C. Clark, president of the Central Bank of Oakland, Calif., and director of the Chamber of Commerce of the United States, said.

He pointed out that the greatest danger we face is that the present spiraling of wages and prices may continue unabated until consumer resistance reaches the point where goods will not be sold, and the crash comes. We have one clear indication of how this operates in the case of residence construction which is reported far below the level of demand because of high prices.

There are several favorable factors that should aid in reaching a normal level of prosperity. (1) The job of physical reconversion is largely accomplished; (2) we know that economic information is important and how it should be analyzed; and (3) the start made in the Taft-Hartley Act toward correction of employer-employee maladjustments.

The "guaranteed annual wage" Mr. Clark emphasized, is not the way to gain regularity in production. This industrial goal is the most difficult management problem in normal times and it involves broad industry-wide problems and adjustments requiring the most expert and careful study.

Teo L. Rosenberg, vice president, Division 6, NECA presided at the Tuesday morning session. This was a forum with papers presented on production problems as the public, utilities, manufacturer, wholesaler and contractor sees them. Harry McClelland, vice president, Bank of America, San Francisco, presented the public's viewpoint.

The big challenge to the construction industry today is to device some means of building great numbers of lower priced homes in the $5,000 class, he said. Only 18 percent of the people in this country can afford to pay

THE PRESIDENT SPEAKS OUT

By ROBERT W. McCHESNEY, President
National Electrical Contractors Assn., Washington, D. C.

What we hope to accomplish is to learn how to rub out some of the costly kinks in our business, to satisfy our customers, to do a better ob, and to make a fair profit. These are the immediate problems. Our opportunity is immense. The demand for our services seems boundless. Our industry is more competent to meet our responsibilities than ever before.

For too long many of us have been engrossed in the engineering and technical side of our industry. We have neglected business promotion and we have not been too aggressive in some cases in protecting our proper economic function as a distributor of electrical materials and equipment. The installation only type of business has become all too frequent. The buyer and the contractor are finding poor satisfaction, high costs, and little profit.

The fastest and most economical way to get an electrical installation is by purchasing the complete job from the electrical contractor—we can prove it!

We damn the manufacturer and the jobber for selling direct—a shortsighted practice which cuts out a good technically trained outlet capable of giving genuine electrical satisfaction—the electrical contractor. But are we doing everything possible to do a good job as a distributor of quality electrical materials and equipment which we install? Let us be honest and realistic with ourselves. Have we gone out and aggressively built up business?

Fred Oertli, Guarantee Electric Co., St. Louis, Mo. and E. L. Buttner, Scott-Buttner Electric Co., Oakland, Calif.

From left to right, J. L. McClure, McClure Electric Co., Dallas, Texas; George Andrae, Herman Andrae Electric Co., Milwaukee, Wis.; H. F. Fischbach, Fischbach & Moore, Inc., New York City.

E. L. Santschi, Division 4 Field Representative NECA, Chicago and Sam Sachs, S. C. Sachs Co., St. Louis, Mo.

more than $5,000 even under today's inflated price and wage levels. There must be a new approach. A new type of house may be the answer; prefabrication or pre-engineered cut may be the solution. Eliminating the refinements in the conventional houses being built may offer the solution; packaging of the plumbing and electrical equipment may contribute.

Mr. McClelland suggested that lower cost may be attained by engineering the house so that the owner may finish part of it by his own labor.

The electrical contractor is the key man in the electrical development of America to the point where by 1976 one trillion kilowatt hours will be produced and distributed annually, George R. Conover, vice president of the Philadelphia Electric Company told the convention.

Achievement of that level of electrical living means $100,000,000,000 worth of electrical construction for utility companies within the next 30 years.

Mr. Conover emphasized that the public utility does not sell the kilowatt hours. Rather, the customer buys it to operate electrical equipment that will do work. Therefore, he said, the utility company's best interest lies in stimulating those branches of the industry which are capable of expanding electrical use. Of these, the electrical contractor is fundamental.

It is to the best interest of the utility, Mr. Conover said, to use the electrical contractor in helping the utility build and maintain some of its facilities for generation and transmission. In recent years our Company has let contracts totalling more than $870,000 for cable installations alone. In addition, during the same period, we have spent more than $6,000,000 with electrical contractors for improvements and installations in its most important stations.

We are entering rather than leaving the electrical age in America, R. A. Neal, vice president of the Westinghouse Electric Corp. said in discussing "Production Problems" from the manufacturer's viewpoint.

The electrical industry still is in a turbulent period of readjustment and will be until problems standing in the way of meeting the huge electrical demand are solved. The manufacturer and the contractor, he said, must cooperate to meet these problems, the major ones being material shortages and rising prices.

There is ample manufacturing capacity to support the electrical part of the construction business and electrical manufacturers are ready to handle the construction load.

The electrical contractor has a responsibility to see that sufficient wiring is provided in all construction to take care of the new and heavier loads of electrical products.

Mr. Neal said that manufacturers had emerged from the war with better production techniques. These include electronics, induction heating and the development of plastics, silicones and glass insulations, painting by molten metal and reduction in weight of motors and transformers.

"Production Problems as the Wholesaler Sees Them" was discussed by J. L. Busey, president of the General Electric Supply Corporation. Only by continued and active merchandising will we be able to support our present day production facilities, Mr. Busey

CODE REVISION

By GEORGE ANDRAE,
Herman Andrae Electric Co., Milwaukee, Wis.

The new Code became effective only eight months ago and already about 40 items have been submitted for interpretation or change in the next code. This indicates what a constantly changing and rapidly developing industry we are in.

Much has been done to simplify the wire tables. I have often recommended that contractors give preference to Type RH, many cable manufacturers say they will concentrate on RH if we contractors will buy RH. So let's standardize on RH in preference to R, especially in sizes 6 and over.

When we talk to customers why talk about wire sizes? Why not recommend a 60 ampere wire or a 100 ampere wire. Let's sell a combination packaged article made up in 30, 60, 100, 200 and 400 ampere sizes with conduit, wire, switch, cutout block, and fuse all matched. This is practical standardization.

I want to urge the manufacturers to give us a wire, other than lead covered, for use where gas and oil vapors are present—an all around underground wire to withstand gas, oil and water and get away from lead covered wire.

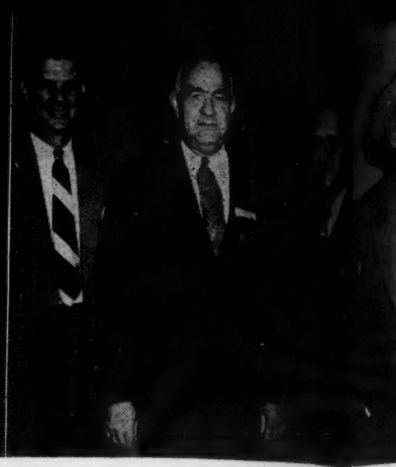
Our purchases will be a big factor in outlet box standardization. There is a lot to be done and I suggest that a joint committee be appointed to work it out. In the same way, I believe that manufacturers and utilities work toward a simplification of service entrance switches and metering devices.

For the interests of the public, some cooperative industry moves should be made to simplify and standardize the wiring materials and wiring methods we use.

Louis D. Kennedy, Joint Committee of Electrical Contractors Assn., New York; Efrem A. Kahn, E. A. Kahn & Co., Inc., Jamaica, N. Y.; and G. E. Scholes, Emerson Garden Electric Co., New York.

J. Fischbach, Fischbach & Moore, Inc., New York; H. G. Martin, Herbert G. Martin, Inc., Yonkers, N. Y.

Jack Collins, Greater Kansas City Chapter. NECA; and John W. Jenner, Shelley Electric Co., Wichita, Kansas.



L. E. Martin, Northeast Texas Chapter, Dallas; George A. Seaman, Division 5 Field Representative NECA; and James D. Land, Zinsco Electric Co.

J. Walter Collins, Chicago, receiving the James H. McGraw Adward Contractors Medal from W. T. Stuart, secretary, Committee of Awards. Mrs. Collins is in foreground.

declared. Only by supporting these production facilities will we be able to benefit by the low unit cost of mass production. Only by selling . . . and selling . . . and selling will we be able to discourage those people who are so anxious to prove our way of life is a failure.

Distribution costs, Mr. Busey explained, are tailored to the demand of the consumer. They may be very high and they may be very low. Money spent for distribution, he emphasized, is a part of total cost, not something added to manufacturing expense.

Standardization and simplification of electrical materials and devices are direct, practical ways to reduce the cost of electrical construction, George Andrae, Chairman of the Technical and Research Committee of NECA pointed out.

The public is the one who pays the high cost of manufacture, distribution and warehousing of many duplicating types of electrical materials and equipment, Mr. Andrae said. Since they serve no useful purpose, they should be eliminated.

There is simplification work to be done in cooperation with manufacturers and electric utilities on such items as eliminating black conduit, eliminating low power factor ballasts in fluorescent lighting, doing away with superfluous types of outlet boxes, simplifying the array of service switches and metering devices; making available a wire—not lead covered—for use where gas and oil vapors or moisture is present; and making available approved bus duct service entrances for high amperage services.

At the banquet J. Walter Collins, secretary of the Electrical Contractors Association of the City of Chicago, Ill., received the James H. McGraw Award Contractors Medal for 1947. Presentation was made by W. T. Stuart, editor of *Electrical Construction and Maintenance* and secretary of the Committee of Awards. The citation accompanying the award read:

The technology of electrical construction takes much of the time and energies of its men, often to the exclusion of equally compelling business considerations which, in a competitive economy, provide the foundation upon which the industry prospers or declines. In recent years many technically competent electrical contractors have been maneuvered in the market place into accepting the inequitable "labor-only" type of contract, involving a maximum of business risk for a substantially reduced return. Keenly aware of the grave consequences to the industry which would follow wide adoption of this contracting procedure, J. Walter Collins, secretary of the Electrical Contractors Association of the City of Chicago, Illinois, from his broad knowledge and experience of electrical contracting operations, dating from 1915,

PRODUCTION PROBLEMS

By CHARLES A. LANGLAIS,
Charles A. Langlais, San Francisco, Calif.

There are two aspects to our production problem, 1) the mechanics of handling the job, and 2) production at costs which will advance the industry. The two divisions are closely related.

Material, labor, job expense and overhead are components of cost before profit and our big problem today is the high cost of all these items, cost which threatens demand. Contingencies cause high prices. One is the escalator clause. We are going to fight against its return. We also need normal flow of materials. If orders are not filled promptly, it adds to our cost of doing business.

There is a great shortage of skilled labor. We are training apprentices but not enough. Our friends in IBEW should foster apprentice training to the utmost. Management has its shortcomings, too. There is the matter of dilution of management. Contractors are attempting to do twice as much work as they are organized for.

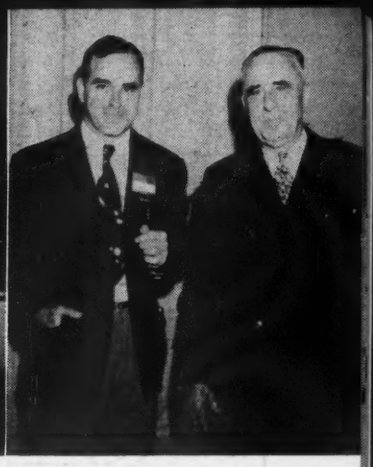
Construction engineering requires well trained personnel. It takes five to 10 years to train a man and provide the necessary experience. More key men must be selected and trained if we are to control our overhead and job expense.

Once our management house is in order, we can turn to our suppliers and demand that they function as suppliers. We can tell labor "You are part of this industry—produce!" And, above all, we should be able to take a lump sum contract and know that our material and labor costs are good and will be maintained for the life of the contract.

Ray Edenfield, Edenfield Electric Co., Nashville, Tenn. and Paul Heydon, Spokane Chapter NECA, Spokane, Wash.

Laurence W. Davis, Treasurer, NECA, Washington, D. C. and E. C. Carlson, Carlson Electric Co., Youngstown, Ohio.

R. W. Ashley, Chicago, Ill. and A. Herrmann Wilson, Electrical Construction Co., Inc., Washington, D. C.



Fred Reinacher, Frank Adam Electric Co., Des Moines, Ia. and Henry J. Reinhardt, Frank Adam Electric Co., St. Louis, Mo.

sought to warn the industry against its dangerous course.

In vigorous speech and forceful writing Mr. Collins challenged the concept of "labor-only" substituting "installation-only" as a term which more clearly embraced the nature of the operation under such contract procedure. Mr. Collins initiated and carried out extensive original research into the costs of "installation-only" contracts. With the cooperation of many electrical contractors he brought together a wealth of accurate and compelling data to support his conviction that it was possible to demonstrate clearly and convincingly how "installation-only" contracts are uneconomical and costly to both the contractor and the buyer.

Through extensive correspondence, through articles in the industry press, through presentations at industry meetings, and through personal contact with electrical men in all parts of the country, Mr. Collins shared the results of his work together with counsel and help in its application to individual situations freely and without thought of acclaim or personal reward.

For his contributions to the improvement and progress of the branch of the electrical industry which he so ably serves at the expense of extraordinary personal effort and time, the Committee of Awards on the recommendation of the judges has voted to Mr. Collins the 1947 Electrical Contractors Medal and Purse given under the James H. McGraw Award.

The judges who recommended Mr. Collins for this honor were A. Lincoln Bush, Belmont Electric Co., New York; Louis Freund, New York; E. A. Kahn, E. A. Kahn & Co., Inc., Jamaica, L. I.; Louis Kalischer, Louis Kalischer, Inc., Brooklyn and W. T. Stuart, secretary, Committee of Awards.

E. C. Carlson, chairman, NECA Labor Relations Committee presided at the Tuesday afternoon session. J. Scott Milne, International secretary, IBEW spoke on "Production Problems as Labor Sees Them". If there is a dwindling production, and I am not sure there is, there seem to be four things we can now do, Mr. Milne said. (1) We can work for a full employment economy. Figures from our Research Department show that the Brotherhood members were 94½ percent employed during 1946. (2) We can appoint a joint committee to make an extended survey of the electrical construction industry to ascertain the facts. (3) After these facts have been gathered and analyzed by the joint committee, we can begin a widespread educational program of management and labor. (4) No matter how these facts pyramid, no matter how these conclusions are reached, we must recognize that labor must have a definite assurance of a fair share in the gains of production and productivity.

Charles A. Langlais of San Francisco, in collaboration with Oliver F. Burnett, Chicago and A. Hermann Wilson, Washington, D. C. presented a discussion on "Production Problems as the Contractor Sees Them". The main problem confronting the electrical contractor today is how to increase productivity so that more electrical jobs can be installed faster to meet the huge demand, and to do this work at lower cost so that the big demand will be sustained and expanded. The principal problems are (1) Material — spotty production, escalator clauses, undependable delivery schedules and distribution policies of suppliers. (2) Labor—shortage of manpower, limited apprenticeship and training activity, uncooperative worker attitude, restrictions on production, lack of knowledge of new developments. (3) Management—lack of and need for adequate training of construction engineering personnel, the development of properly trained foremen,

(Continued on page 205)

ELECTRICAL INTERDEPENDENCE

By N. J. McDONALD,
Thomas & Betts Company, Elizabeth, N. J.

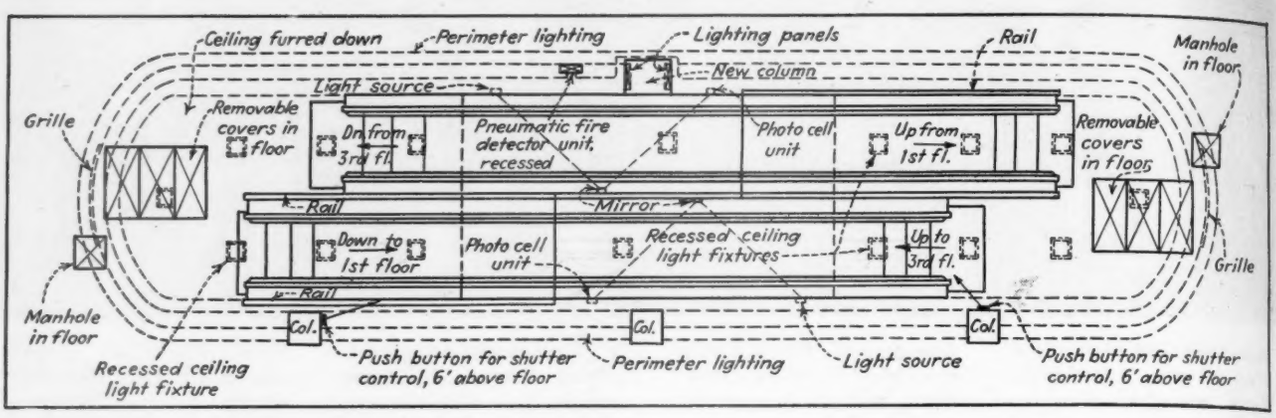
You are the electrical industry's real contact with the customer. And the greatest asset we all share is customer satisfaction. You will solve your production problem. There is another problem of production — how are we going to increase the use of electricity? Unless we expand its use, we have no market for the factory's product, your engineering and installation management, nor for skilled mechanics.

This is what your Interdependence Program is all about. It is the practical realization that every branch of our industry is so interwoven in interest that each depends upon the other.

Electrical Interdependence means that everyone who gets a living out of the electrical industry must do something practical to increase the use of electricity.

The electrical contracting industry is especially fortunate in having employees of a type much higher than the average in industry. Your average worker is a skilled mechanic who not only knows his business but knows pretty much what goes on around him. Added to this he is in touch with the customers of the electrical industry. Your industry is very important in this program.

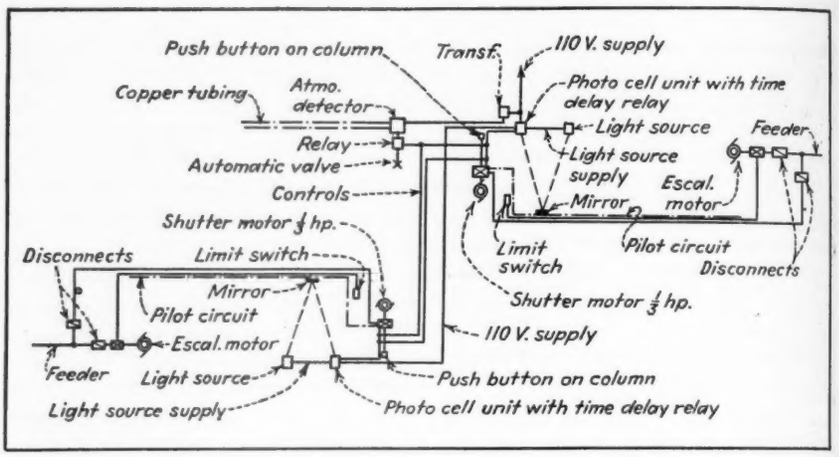
The Interdependence idea is firmly rooted. The three leading Associations in the industry — NEMA, NECA and NEWA have endorsed it. Several Electrical Leagues have followed suit. Others are interested and will fall in step. Our big task now is to do the job.



Typical floor plan shows location of photocell units, incandescent canopy downlights and fluorescent perimeter lighting arrangement, floor plan of escalator installation and location of motors.

Photocell controls, multiple safety devices and modern lighting are features of new high-capacity moving stairway installation in progressive department store.

By Hugh P. Scott



Photocell controls on each floor are cross connected to both shutter motors so that both shutters close upon activation of either photocell. Travel of shutter activates limit switch to stop escalators. Atmo detectors activate shutter motors and open automatic sprinkler valves.

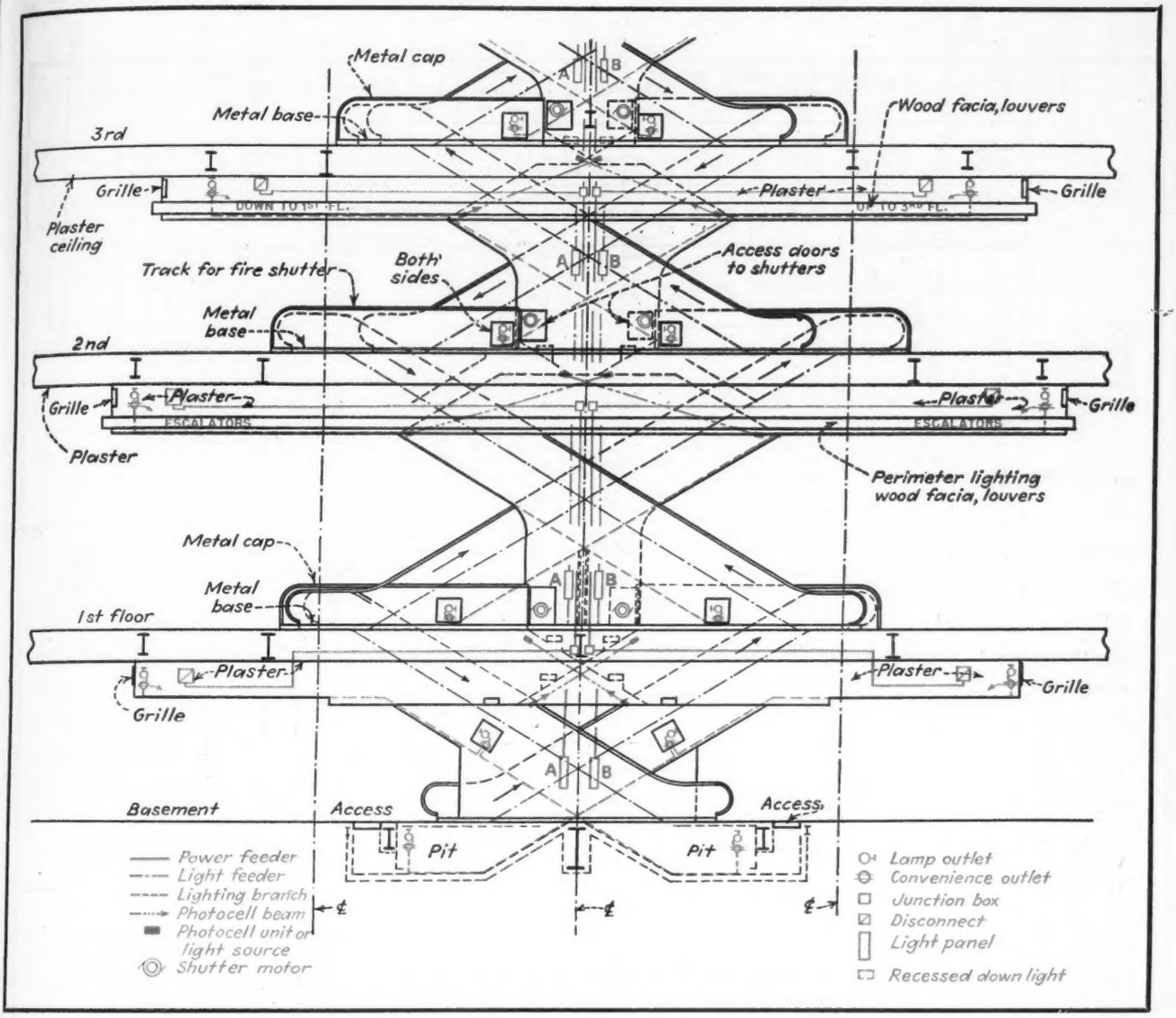
Escalator Installation

THE recently completed escalator installation in Kresge Newark's twelve-story department store presents to shoppers of northern New Jersey the finest and most recent developments in the field of moving stairways. Operating at 90 feet a minute at an inclination of 30 degrees, each four-foot wide unit is rated for a normal capacity of 8000 passengers an hour and can safely carry an additional 50 percent for peak holiday demands. Passenger safety is assured by multiple electronic operating controls and steel fire shutters that, for the first time in the history of vertical transportation, are motivated by smoke-detecting photoelectric circuits and heat-detecting thermostatic elements. Light sources for illuminating the escalators are contained in modern canopies above each pair of stairway units and include both perimeter cove-mounted fluorescent lamps and soffit-recessed incandescent downlights.

The new escalators, designed and manufactured by the Otis Elevator Company, were installed in accordance with plans and specifications prepared by Edward E. Ashley, the electrical and mechanical consulting engineer for the project. The existing electrical distribution systems, throughout the area occupied by the new escalator installation, was completely revamped by electrical contractor Edward J. White. Structural alterations were by Mahony-Troast, the builders.

The new two-way moving-stairway system consists of eight modern 4-foot wide escalators, installed in pairs from the basement to the fourth floor, and the six original 3-foot wide units which are relocated and paired to carry shoppers between the fourth and seventh floor levels. The total vertical travel of the installation is 120 feet.

Installing the new units, removing and relocating existing equipment, cutting new floor openings and sealing former escalator wells presented a variety of installation problems which made the job both exacting and interesting from an electrical viewpoint. In



Two power feeders (each consisting of three 500 MCM cables in 4-inch conduit) connect all escalator and fire shutter motors to main switchboard on 12th floor. Lighting circuits for escalator canopy illumination are connected to existing lighting panels on the 9th floor.

Escalators are stopped and steel shutters automatically close floor openings in event of fire. Controls include photocell units for smoke detection, thermostatic elements to detect excessive temperatures, manual push-button motor controls and hand cranks.

areas formerly occupied by original stairways; escalator wiring, sprinkler systems and lighting fixtures were removed. An extended underfloor duct system was built into the new floor slabs over former floor openings. Hung ceilings were suspended beneath the new reinforced concrete slabs. Where new floor openings were established it was necessary to remove or reroute both high and low tension floor ducts, installing new junction boxes and outlets as required. New three-phase feeders and disconnect switches were installed for all motors operating escalators and fire shutters. Smoke and fire detector circuits were established. New lighting circuits and air conditioning ducts were installed.

The main motor drive assembly of each escalator is located beneath the comb plate at the upper landing and motivates the step chains. Escalator motors range in size from 12 to 20 horsepower, depending upon the various floor heights, step widths, unit capacity and machine design. Total rated capacity for the 14 units is 244 horsepower. Motors and controllers, specifically designed for escalator service, are carefully aligned for close tolerances to promote quiet, smooth operation. To prevent transmission of vibration, the structural steel machine bases are insulated from the framework of the building by thick rubber mounting pads. Small and compact controllers, activated by light weight switches and relays, control the starting, stopping and reversals of the motor in accordance with signals originating from either manually operated pushbuttons or from automatic safety switches.

Transmission of power to the escalators is through step chain sprockets, held in alignment by a connecting barrel housing and rotating about a heavy stationary axle on the main drive assembly. Secondary sprockets transmit power to the handrail drive mechanism. When it is required to stop an escalator for any reason (cessation of

[*Continued on page* 207]

TABLE I – CONSTRUCTION PERIODS FOR ECONOMIC OPERATION OF ELECTRICAL INSTALLATION PROJECTS – INDUSTRIAL.

SEE NOTES BELOW

CONTRACT DATA						LABOR		CONSTRN. PERIODS-SEE SKETCH BEL.									TOTAL PERIOD		AV.NO OF MEN EMPL.
SELL PRICE	BASE COSTS			JOB COSTS & MARKUP		MAN HOURS	MAN DAYS	1 & 6			2 & 5			4 & 3					
	MATERIAL	LABOR	L. & M.	%L&M	DOLLARS			DAYS	MEN AV.	MAN DAYS	DAYS	MEN AV.	MAN DAYS	DAYS	MEN AV.	MAN DAYS	DAYS	WKS.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
10,000.	3,750.	2,500.	6,250.	60.0	3,750.	1,250	156	10	2	20	12	4	48	15	6	90	37	7.4	4.2
25,000.	9,450.	6,300.	15,750.	58.7	9,250.	3,150	394	12	2	24	35	6	210	16	10	160	63	12.5	6.3
50,000.	19,200.	12,800.	32,000.	56.2	18,000.	6,400	800	12	2	24	52	8	416	30	12	360	94	19.	8.5
100,000.	40,800.	27,200.	68,000.	47.7	32,000.	13,600	1700	15	4	60	75	12	900	37	20	740	127	25.4	13.4
200,000.	84,000.	56,000.	140,000.	42.9	60,000.	28,000	3,500	20	4	80	125	16	2,000	60	24	1,440	205	41	17.1
300,000.	132,000.	88,000.	220,000.	36.5	80,000.	44,000	5,500	30	5	150	145	22	3,190	60	36	2160	235	47	23.4
400,000.	178,500.	119,000.	297,500.	34.5	102,500.	59,500	7,440	30	5	150	160	26	4,160	70	45	3,150	265	53	28.5
500,000.	225,000.	150,000.	375,000.	33.3	125,000.	75,000	9,375	35	5	175	175	30	5,250	75	53	3,975	285	57	33.
600,000.	270,000.	180,000.	450,000.	33.3	150,000.	90,000	11,250	40	5	200	185	34	6,290	80	60	4,800	305	61	37.
750,000.	337,000.	225,000.	562,000.	33.3	187,500.	112,500	14,060	42	7	294	225.	37	8,325	85	64	5,440	350	70	40.
1,000,000.	450,000.	300,000.	750,000.	33.3	250,000.	150,000	18,750	45	11	495	270	45	12,150	85	72	6,120	400	80	47.
1,250,000.	570,000.	380,000.	950,000.	31.7	300,000.	190,000	23,750	50	14	700	295	54	15,930	90	80	7,200	435	87	54.5
1,500,000.	680,000.	460,000.	1,140,000.	31.6	360,000.	230,000	28,750	60	15	900	300	66	19,800	90	90	8,100	450	90	64.
1,750,000.	801,000.	534,000	1,335,000.	31.0	415,000.	267,000	33,375	65	16	1,040	304	72	21,888	95	110	10,450	465	93	72.
2,000,000.	915,000.	610,000	1,525,000.	31.0	475,000.	305,000	38,125	70	18	1,260	310	79	24,490	100	125	12,500	480	96	80.

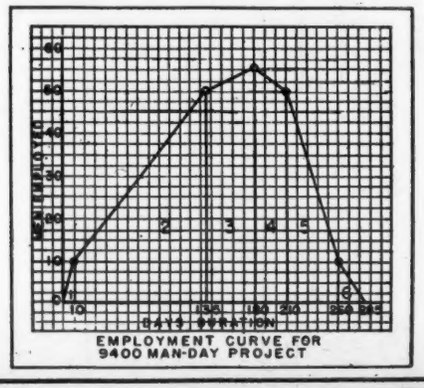
NOTES-CALC.& BASE FIGS.:-

1– AS FIGS. ARE ONLY APPROX., MINOR IRREGULARITIES HAVE NOT BEEN IRONED OUT.

2– BASE FIGURES– A-"60/40" PROJECTS (MAT. 60%-LAB. 40%). B-LAB. RATE $2.00/HR. C.-5 DAY WEEK. D-INS. & EMPL. BENEFITS=14.5%. E-ENG., SUPERVISION, TOOLS, INSURANCES, ETC. INCLUDED IN JOB COSTS.

3– PERIODS FOR CONSTRUCTION TIME BASED ON PROGRESS FREE OF INTERFERENCE FROM OTHER TRADES AND OPERATIONS.

4– CONTRACTORS, MANNED, EQUIPPED, AND ORGANIZED TO EXPEDITIOUSLY CARRY ON THE WORK.



EMPLOYMENT CURVE FOR 9400 MAN-DAY PROJECT

ESTIMATED OPTIMUM DURATION FOR A JOB REQUIRING 9400 MAN-DAYS (SEE $500,000 PROJECT)

PERIOD	DAYS	NO. OF MEN-AV.	MAN DAYS
1	10	5.	50
2	125	30	3750.
3	45	53.	2385.
4	30	53	1590.
5	50	30	1500.
6	25	5	125.
TOTALS	285		9400

ELECTRICAL CONTRACTORS' ASS'N. OF CITY OF CHICAGO

Volume-Duration Studies.....Part II

By Ray Ashley
Research Engineer
Electrical Contractors Association of City of Chicago

Annual volume determines the size of individual projects a contractor can efficiently handle. A discussion of contractor's limitations and the "one-third volume" rule.

REGARDLESS of a contractor's aspirations, there are certain limits beyond which he can not venture with impunity. His ability to finance, equip, man, engineer, superintend and manage the job, must all be weighed if he is to select work judiciously.

We well know that all too often contractors let their wishes master their reason, and take on work which they are unable to handle profitably. That is why many, after years of struggle, have little or nothing to show for their effort. These same contractors blame their failures on competition rather than recognize the truth and admit their own stupidity is the cause.

On the other hand, as we survey the field, we find that some of our wealthier contractors are what we choose to class as "small operators". *They have money and are "small operators", because they have operated within their limits.*

Figures indicate that normally *a contractor cannot expeditiously carry on any project which in volume exceeds one third his average volume for the preceding three years.* There are exceptions, however. We have contractors who specialize in power generating plants, railroad electrification, and other types of work which go in cycles. The contractor has no control over the cycles, and any type of construction which does not supply an even flow of work may have to pay a premium.

Another exception are those contractors who have large industrial accounts. Customers of such contractors periodically have expansion programs and those contractors may have to up their production 50 percent or more. It is remarkable how well some of the better contractors meet such demands. They have the money to finance the job, ample tools and equipment, and their close contact with the owners enables them to solve their construction problems. By following the job from its inception, they are able to complete all engineering, plans and shop drawings before construction starts. When work does start, the engineers are free to go to the project site. Being assured of the contract, they can also pave the way to solve their manpower problems. Other work is cleaned up as much as possible in readiness to concentrate on the big job. When work gets under way, men who have been loaned to other contractors are called back and, as needed, men are borrowed from other contractors or taken from the open market.

Under such conditions there are bound to be some mechanics below normal. The same interest in the work will not exist as would if all men were recruited from the contractor's regular crews. The buyer may realize this, but he should also realize that the lack of productivity of a few mechanics can be more than offset by the engineering and management ability of a contractor who has always served him well.

The "One-Third Volume" Rule

Going back to the "1/3 ratio" rule (maximum project equal to one-third the average annual volume), let us study some figures. In normal times manpower requirements must be met principally by men recruited from the contractor's regular crews. A job out of proportion will either suffer from the lack of suitable mechanics, or other jobs will have to be bled to supply the men.

According to the "1/3 volume" rule, only contractors having *an annual*

TABLE II*—VOLUME—DURATION
(Individual Projects)

Approximate manpower requirements (average and peak) for industrial electrical projects completed within optimum periods.

Contractor's Sell Price Dollars (1)	Approximate Labor Man Days (2)	Man Weeks (3)	Requirements for Economic Operation Construction Period Days (4)	Weeks (5)	Mechanics Aver. (6)	Peak (7)
10,000	150	30	35	7	4.3	6
25,000	400	80	65	13	6.2	10
37,500	600	120	80	16	7.5	12
50,000	800	160	95	19	8.5	15
100,000	1,700	340	130	26	13	22
150,000	2,600	520	175	35	15	24
200,000	3,500	700	200	40	17.5	28
300,000	5,500	1,100	235	47	23.5	40
400,000	7,440	1,488	265	53	28	50
500,000	9,370	1,874	285	57	33	56
600,000	11,250	2,250	305	61	38	64
750,000	14,100	2,820	350	70	40	70
1,000,000	18,750	3,750	400	80	47	80
1,250,000	23,750	4,750	435	87	55	90
1,500,000	28,750	5,750	450	90	64	100
1,750,000	33,400	6,680	465	93	72	120
2,000,000	38,100	7,620	480	96	80	150

*NOTES:
(1) Tables for industrial work.
(2) Complete installation by contractor (60/40 project).
(3) Labor rate, $2.00 per hour.
(4) Insurances and association dues, 14.5 percent.
(5) Engineering by contractor.
(6) High operating costs (engineering, supervision, tools and equipment, management, etc.) necessary to get high labor productivity.

TABLE III—MANPOWER — VOLUME TABLES*
(Total Annual Volume)

How variation in operating costs, labor rates affect manpower requirements for identical total annual volumes of industrial work (see Notes and Colums I and II).

Annual Volume (Sell Price) In Dollars	Average Number of Mechanics Employed (Approx.) Column I High Operating Cost Low Direct Labor (See Notes)	Column II Low Operating Cost High Direct Labor (See Notes)
50,000	3	5.5
100,000	6.5	12.5
200,000	12	23
300,000	19	37
400,000	26	56
500,000	33	66
600,000	40	80
750,000	50	102
1,000,000	68	
1,250,000	85	
1,500,000	102	
1,750,000	120	
2,000,000	140	
2,500,000	172	

*NOTES:

COLUMN I—Calculations are based on the following:—
(1) Complete installations—all material and labor by contractor.
(2) "60/40" Projects—(Base cost 60% material, 40% labor).
(3) Labor rate, $2.00 per hour.
(4) Insurances and association dues, 14.5 percent of labor.
(5) Equitable markups.
(6) See Part I, September 1947 EC&M, for sample estimates and other stipulations.

COLUMN II—Calculations are based on the following:—
(1) Complete installations—all material and labor by contractor.
(2) "50/50" Projects.
(3) Labor rate, $1.50 per hour.
(4) Insurances, 8 percent.
(5) Low operating costs.
(6) Direct job labor costs (man-days) high, due to lack of equipment, construction drawings, etc.

volume of $150,000 or more would be able to economically carry on a $50,000 project. A study of manpower requirements will point out one of the limiting factors.

We already have figures (see table I) which give the approximate requirements of a $50,000 project. These figures must now be compared with those of a contractor in the $150,000 class.

To get the approximate manpower requirements of a $150,000 *annual volume*, we can set up some hypothetical figures. Let's assume that the contracts making up the total business are as follows:

5 contracts averaging	$25,000 =	$125,000
25 contracts averaging	1,000 =	25,000
Totals 30 contracts		$150,000

Average of all contracts = $\frac{\$150,000}{30} = \$5,000$

Table I, column 5, shows that the total of job costs and markups for a $10,000 project, is 60 percent of the combined base costs of material and labor. For jobs averaging $5,000 (sell price) we shall use 65 percent. The sell price of the average job would then be 165 percent of the combined cost of material and labor. Again the reader should be reminded that we are dealing with a special class of work, performed by a highly efficient contracting organization. The 65 percent added to base costs represents, in part, high operating costs—designed to keep direct job labor to a minimum (See Stipulations in Part I, pg. 52, September, 1947 issue of EC&M).

Example I:

The division of job costs for a $150,000 *annual volume* (M/L ratio—60/40) can be figured as follows:—

Purchase Price Material (60%) $= 60 \times \frac{150,000}{165} =$	$54,546
Pay Roll — Labor (40%) $= 40 \times \frac{150,000}{165} =$	36,364
Total Base Cost	$90,910
Direct Job Costs and Markups (65%)	59,090
Total Volume (Sell Price)	$150,000

The above figures show the labor (payroll) division to be $36,364. At $80.00 per week and an average of 50 weeks per man, the average salary per mechanic would be $4,000.

Average number of men employed $= \frac{\text{Total Payroll}}{\text{Aver. Salary}} = \frac{36,364}{4,000} = 9.041$

For the sake of discussion, we shall add approximately 10 percent and say the average number of mechanics employed is ten.

Example II:

Under other conditions, the estimated manpower might be as much as 50 percent more. **We cannot go into details nor cover all conditions, so for illustration let us assume the following conditions and work out a second example.**

Material labor ratio = 50/50
Operating costs plus markups = 50 percent of base cost
Labor rate $1.50 per hour ($3,000/yr.)

For a $150,000 volume, the total labor will then be:

$$50 \times \frac{150,000}{150} = \$50,000$$

The average number of employees would be:

$$\frac{50,000}{3,000} = 16.6$$

We could use 10 men or 16 men and the ⅓-volume rule would still work out if, in each case, the same conditions were assumed for the average individual job as were used for the annual volume. Since, however, we have been dealing with work completed in optimum time by efficiently operating contractors, and complying with many other stipulations (see Part I, September, 1947, EC&M), we shall use the 10-man figure.

If the contractor operates economically, his work would have to be so distributed that the number of men employed would be fairly uniform throughout the year. With an overall average of ten men, it is not likely that he could spare more than five (average) for any one job. Any additional men required would have to be obtained from outside sources.

Table II shows the average number of men required for a $50,000 project, completed in the optimum period of 19 weeks, to be 8.5. For the $150,000 contractor to be able to handle the contract, three things would be necessary.

1. The construction period would have to be extended.
2. He would have to have an unusual distribution of contracts.
3. Approximately 40 percent of

[Continued on page 209]

PLANNED LIGHTING Layout and Design Data

LIGHTING system design and layout practices are the core of planned lighting application. Between the appraisal of the seeing task and the achievement of an effective and economical lighting installation a number of critical selections and choices must be made.

Convenient data and accumulated experience together with a wide variety of available lamps, components and fixtures makes good lighting results relatively easy to achieve. Planned lighting, with its great potential benefits to industry, commerce and the home, is a practical technique available to all who have the training, experience and wisdom to apply it. As in other fields of engineering application, however, superior design and superior craftsmanship are essential to superior results.

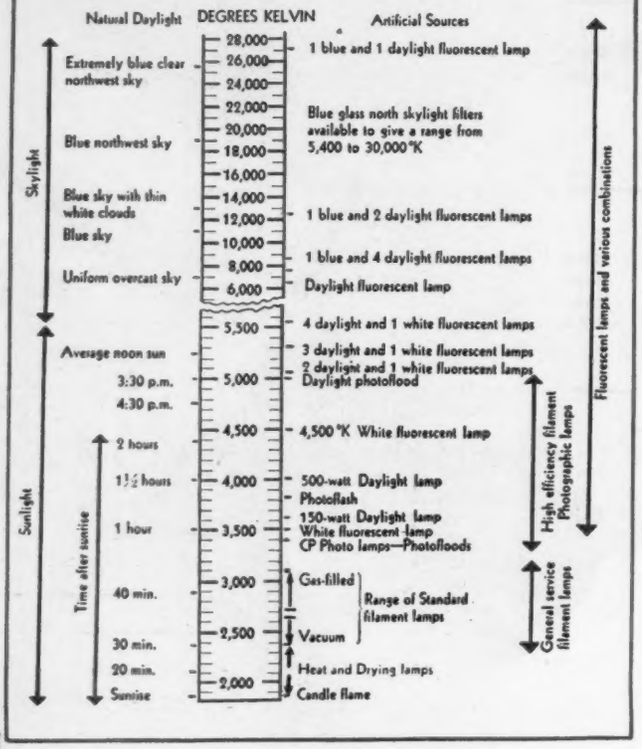
Planned lighting offers a tremendous scope for bold and imaginative applications of modern lighting equipment and techniques. The best practical interior illumination values are still far short of the daylight intensities and qualities under which our eyes evolved and the vital sense of sight developed. And most of the existing lighting under which we work and play is far below already recognized and practical illumination standards.

Lighting affects everyone directly in his daily affairs. Its progress cannot be appraised by the frontiers of scientific and engineering development alone. The countless applications of lighting, however small or large are a far more realistic measure. Each opportunity for improvement in one of them is a challenge to contribute to lighting progress as a whole.

The art of illumination and the lighting industry have a wealth of technical literature and experience from which lighting men can draw help and guidance. The essence is contained in many charts and tables which simplify the task of accurately predicting lighting values from the many variables which affect the lighting application. These data are the practical tools of applied lighting, and of practical lighting men.

In the following pages the editors have brought together a selection from the most essential and useful data for lighting system design and layout. A large proportion is derived from material prepared for the comprehensive new IES Handbook, and made available to us through the courtesy of the Illuminating Engineering Society and the Handbook editors.

COLOR QUALITY OF ILLUMINATION



LEVELS OF ILLUMINATION

	Footcandles
Starlight	0.0002
Moonlight	0.02
Street Lighting	0.6 – 1.2
Daylight	
At North Window	50-200
In Shade (Outdoors)	100-1000
Direct Sunlight	5000-10,000
RECOMMENDED ARTIFICIAL LIGHTING LEVELS	
Office Lighting	30-50
Store Lighting (General)	20-50
School Lighting (Class Rooms)	30-50
Drafting Rooms	50-100
MANUFACTURING PROCESSES	
Rough	20-30
Medium	30-50
Fine	50-100
Extra Fine	100-200

Source: Westinghouse Lighting Handbook

PLANNED LIGHTING

DESIRED

THE quality of a finished lighting installation is dependent upon several factors. The *quantity* of light, until recently considered a major consideration, is important. However, recent studies of comfort and ease of seeing put equal importance on *quality* of light, color harmony, low brightness ratios, and other similar factors.

Illumination levels for artificial lighting systems are guided by the type of occupancy in the area to be lighted, and the degree of criticalness of the seeing tasks involved. For general lighting, intensities up to 100 footcandles are currently recommended. Where seeing tasks are involved, values below ten footcandles should generally be avoided. Ten to 20 footcandles are considered adequate for rough work, such as the lighting of conference rooms, cafeterias, passageways, and of packing, loading and shipping departments. As the degree of criticalness of the seeing task increases, as in offices, stores, classrooms and drafting rooms, lighting intensities of from 20 to 100 footcandles are recommended. Tables at the top of this and the opposite page give recommended lighting intensities for a number of specific types of seeing tasks or area occupancies.

Supplementary lighting is normally used to provide lighting levels in excess of 100 footcandles. Such intensities are desirable in display lighting in stores and show windows, for sewing on dark materials, inspection, assembly of fine parts, color work and color identification.

The age of employees is an important consideration when selecting the lighting intensity for any specific work area. More light is required for equal ease in seeing for older persons, since eyes become less responsive with age.

Fluorescent lamps have opened up a new factor for consideration when planning a lighting system. These lamps are made in four degrees of whiteness for general lighting, as well as in a variety of colors for decorative and spectacular lighting effects. This makes it necessary to consider the *color quality* of the light best suited for each area or type of seeing task. It is now possible to choose artificial light sources, or combinations, which will produce practically any *color quality* desired for the final lighting result. Color quality of the resulting illumination is particularly important in the lighting of merchandise in stores, or in the manufacture of products involving color.

In general, incandescent or filament lamps produce a yellowish light, with low wattage lamps being more yellow and high wattage lamps increasing in whiteness as the wattage increases. Mercury vapor lamps appear bluish-white in color. Fluorescent lamps are made in soft white, 3500-degree white, 4500-degree white and daylight, or 6500-degree white. Thus, when a warm tone is desired in the final lighting result, low wattage incandescent lamps or soft white fluorescent lamps are appropriate. Noon sunlight quality of light can be produced by 4500-degree white fluorescent lamps, and north skylight quality by daylight

RECOMMENDED ARTIFICIAL ILLUMINATION LEVELS

APPLICATION	Inadequate for Most Seeing Tasks / Rough Work / Adequate for Casual Seeing Tasks / Recommended for Critical Seeing Tasks / Specialized Applications	FIXTURE TYPE
Offices and public buildings	Auditoriums, Cafeterias, Conference, Passageways, Reception — Woodworking, Casual Desk Work, Class Rooms, Filing, Libraries — Accounting, Bookkeeping, Critical Desk Work, Sight Saving, Stenographic — Drafing, Business Machines — Color Work — Color Work — Hospital Operating	Direct, Diffuse, Semi-indirect, Indirect
Stores	Stock Rooms — Circulation Areas — General Merchandising — Counter Display, Showcases, Show Windows, Wall Cases — Display Work, Show Windows — Display Work, Show Windows — Display Work, Show Windows	
Industrial	Loading, Packing, Shipping, Washrooms — Foundry Work, General Processing, Pressing—Shearing, Rough Work — Automatic Machinery, General Assembly, General Fabrication, Sewing, Type Setting — Fine Assembly, Fine Machining, Inspection, Proofreading — Color Inspection, Extra Fine Assembly, Fine Inspection — Color Identification	Direct, Diffuse
	0 — 10 — 20 — 50 — 100 — 200 — 500 — 1000	

FOOTCANDLES

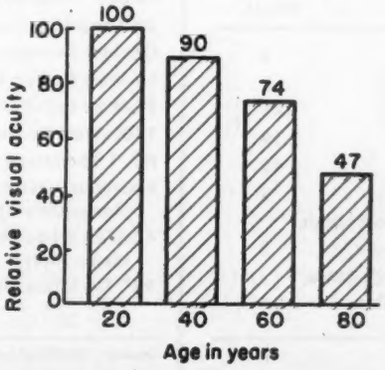
GENERAL LIGHTING — SUPPLEMENTARY LIGHTING

LIGHTING RESULTS

fluorescent lamps, or by high wattage incandescent lamps and daylight-blue glass filters. Other color qualities, as compared with natural daylight throughout the day, can be matched by combinations of the above light sources, or by combinations of these sources and colored lamps, such as blue, green, yellow, red and orange.

Ceiling and wall colors and finishes are also important factors in lighting, as are the colors and finishes of furniture, machines, draperies and other furnishings. The apparent color of any surface is affected by the color quality of the light falling upon it. Also, light reflected from any object is affected by the color of the object.

Many solutions are, of course, possible for any specific lighting problem. Quantity and quality of the final lighting result are of prime importance where ease of seeing is paramount. Many lighting problems involve decorative treatments and aesthetic considerations. Usually, it is possible to obtain decorative treatment with white light on colored surfaces, or with colored light on white or neutral surfaces, or with a combination of both. The lighting result required for a cinema auditorium, ball room or night club, for example, will involve aesthetic consideration and decorative treatment primarily. Problems of architectural and decorative treatment are subject to the individual taste of the lighting designer and the amount of money available to do the job. The fact that any specific lighting problem may be successfully solved in many ways is largely responsible for the unusual fascination of lighting design work.



OLDER EYES NEED MORE LIGHT

Any well informed lighting engineer can easily plan a satisfactory lighting system to provide a specific lighting result. The major problem is to determine exactly what that lighting result should be, or to adequately define and describe this result—to the architect, decorator or customer. Footcandles can be measured with an instrument. So can brightness, to establish brightness ratios and contrasts. But many factors comprising a lighting result cannot be measured. They pertain to comfort in seeing, harmony in color treatment, architectural and decorative harmony and other considerations. They all contribute to the success of the final lighting result desired and must be thoroughly understood by the lighting engineer.

Watts	Bulb	Initial Lumens	Initial L. P. W.	Rated Average Life (hrs.)
25	A-19	260	10.4	750
40	A-19	465	11.7	1,000
60	A-19	835	13.9	1,000
100	A-21	1,630	16.3	750
150	PS-25	2,600	17.2	750
200	PS-30	3,650	18.3	750
300	PS-35	5,900	19.7	750
500	PS-40	10,000	20.0	1,000
750	PS-52	14,550	19.4	1,000
1000	PS-52	21,500	21.5	1,000
1500	PS-52	33,000	22.0	1,000
2000	PS-52	44,000	22.0	1,000

Source: Sylvania Electric Products, Inc.

* Available for 120 volt operation. Some lamps also available for other voltages. For additional data and listing of other types of lamps, see lamp manufacturers' data bulletins, or IES Lighting Handbook.

STANDARD* INCANDESCENT LAMPS

Watts (Lamp Only)	Base (Bipin)	Nominal Length (Inches)	Bulb	Initial Lumen Output (100 Hrs.)			
				Soft White	3500° White	4500° White	Daylight
(PREHEAT-STARTING)							
15	Medium	18	T-8	487	622	585	555
15	Medium	18	T-12	472	600	570	517
20	Medium	24	T-12	720	940	860	800
30	Medium	36	T-8	1720	1485	1380	1350
40	Medium	48	T-12	1760	2310	2110	1960
40	Mogul	60	T-17	....	....	2100	....
100	Mogul	60	T-17	3350	4300	4000	3900
(INSTANT START)							
40**	Medium	48	T-12	....	2320	2100	1920
40**	Mogul	60	T-17	....	....	2100	....

Source: IES Lighting Handbook

* Lamps listed are for general lighting purposes. Additional lamps for special application and for decorative lighting are available. See lamp manufacturers' catalogs, or IES Lighting Handbook.

** Bipin base has pins short-circuited inside end caps. Lamps will not operate on preheat ballast circuits.

STANDARD* FLUORESCENT LAMPS

PLANNED LIGHTING

SELECTION of

LISTED on these two pages are standard light sources normally used for general lighting purposes. Many other lamps are available. Lamp manufacturers' catalogs should be consulted for other wattages, shapes, ratings, and listings of colored light sources.

Factors to be considered in selecting the light source for any specific application include color quality of the light produced, lamp life, lumen depreciation throughout life, efficiency of converting electrical energy into light, stroboscopic effect, and effect of ambient temperature surrounding the light source on its light output. When fluorescent lamps are indicated as being suitable for a specific lighting problem, it is also necessary to determine the type of cathode which is most suitable for the job.

Light sources normally used for general lighting include incandescent, mercury vapor and fluorescent. Incandescent lamps are point sources of light, and light distribution can be controlled fairly accurately. Rated life is low, averaging 1000 hours actual burning. Light output is not affected by changes in room temperature. Mercury vapor lamps have long life, averaging 3000 to 5000 hours, are approximately double the efficiency of incandescent lamps, have approximate point source for accurate light control, but are subject to decrease in efficiency in abnormal room temperatures.

Fluorescent lamps are line sources and are excellent for diffuse distribution. Slimline lamps afford fair light control because of their small diameter. Rated life is affected by frequency of starts, and varies from 2500 to 6500 hours.

COMPARATIVE STROBOSCOPIC EFFECT OF VARIOUS LAMPS
Operated on 60-Cycle Supply

Lamp and Method of Operation	Relative Stroboscopic Effect
200-Watt Incandescent	1
40-Watt Incandescent	7
Green Fluorescent—Single-Lamp Ballast	11
White Fluorescent—Single-Lamp Ballast	19
Blue Fluorescent—Single-Lamp Ballast	49
White Fluorescent—Two-Lamp Ballast	9
White Fluorescent—Three Lamps: Single-Lamp Ballasts on Separate Phases of a Three-Phase Circuit	3
White Fluorescent—Three Lamps, One on Single-Lamp Ballast, Remaining Pair on Two-Lamp Ballast	14

Source: IES Lighting Handbook

EFFICIENCIES OF VARIOUS LIGHT SOURCES
Approximate Lumens per Watt

Candle (Luminous Efficiency Equivalent)	0.1
Oil Lamp (Luminous Efficiency Equivalent)	0.3
Original Incandescent Lamp (1879)	1.4
60-Watt Carbon Filament Lamp (1905)	4.0
60-Watt Coiled Coil Tungsten Filament Lamp (1947)	13.9
1000-Watt General Service Lamp (1947)	21.5
No. 1 Photoflood Lamp (1947)	34.6
400-Watt A-H1 Mercury Vapor Lamp (Lamp Only) (1947)	40.0
40-Watt White Fluorescent Lamp (Lamp Only) (1947)	58.0
96" T-8 White Slimline Lamp (Lamp Only) (1947)	64.0

Source: Westinghouse Lighting Handbook

Nominal Length (Inches)	Bulb	Watts (Lamp Only)	Lumen Output		Footlamberts	
			3500° Wh.	4500° Wh.	3500° Wh.	4500° Wh.
100 MILLIAMPERES (LAMP CURRENT)**						
42	T-6	16	915	880	1680	1600
64	T-6	24	1410	1370	1670	1600
72	T-8	22	1405	1340	1050	1000
96	T-8	30	1920	1800	1065	1000
200 MILLIAMPERES (LAMP CURRENT)**						
42	T-6	25	1400	1320	2590	2450
64	T-6	39	2100	2150	2560	2450
72	T-8	38	2350	2250	1755	1650
96	T-8	52	3250	3050	1790	1650

ss: IES Lighting Handbook, and G. E. Company, Bulletin LD-1
Slimline lamps have a single pin base – for instant-start hot-cathode eration.
limline lamps now available for 300 Milliamperes (Lamp Current) operation.
ta not yet available.

STANDARD SLIMLINE* FLUORESCENT LAMPS

Lamp	Burning Hours per Start		
	3	6	12
6-W 9" T-5	2500	—	—
8-W 12" T-5	2500	—	—
13-W 21" T-5	2500	—	—
14-W 15" T-12	2500	—	—
15-W 18" T-8	2500	4000	6000
15-W 18" T-12	2500	4000	6000
20-W 24" T-12	2500	4000	6000
30-W 36" T-8	2500	4000	6000
40-W 48" T-12	2500	4000	6000
100-W 60" T-17	3000	4500	6500
Instant-Start			
40-W 48" T-12	2500	—	—
40-W 60" T-17	2500	—	—
Slimlines (All Types) Circline			
32-W 12" Diam. T-10	2500	—	—

RATED AVERAGE LIFE OF FLUORESCENT LAMPS IN HOURS

Tube Diameter (Outside)	Current	Volts Per Foot	Watts Per Foot	Initial Lumens Per Foot		
				3500° Wh.	Daylight	Warm Wh.
25	24	63	1.5	74	71	80
	48	57	2.7	142	132	150
	96	50	4.8	271	247	286
20	24	72	1.7	87	80	94
	48	64	3.1	172	159	184
	96	96	5.5	322	299	339
15	24	90	2.2	108	98	110
	48	81	3.9	190	172	203

Source: IES Lighting Handbook
* Instant-starting lamps. Overall lengths, lumen output, life and voltages have been standardized by the Fluorescent Lighting Association.
Initial Lumens per foot for daylight lamps also apply to soft white lamps.

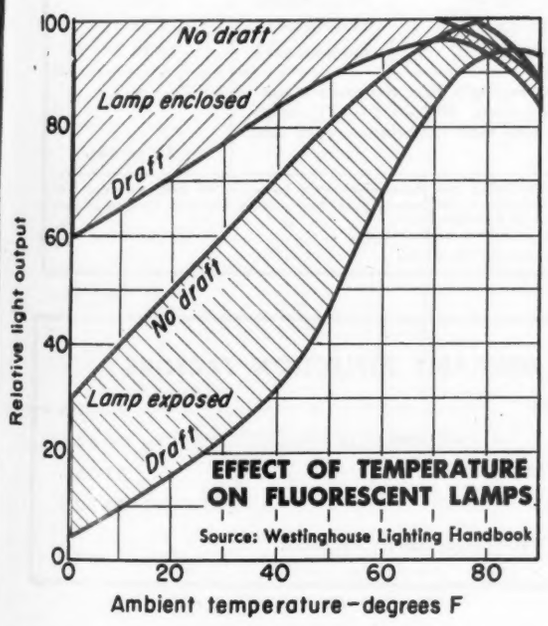
CYLINDRICAL (COLD) CATHODE* FLUORESCENT LAMPS

Watts (Lamp Only)	Type	Bulb	Lumens at 100 Hrs.	L.P.W. at 100 Hrs.	Rated Av. Life	
					5 hrs./st.	10 hrs./st.
100	H-4	T-10	3,000	30	1000	—
250	H-5	T-14	10,000	40	2000	3000
400	H-1	T-16	16,000	40	3000	5000
1000	H-12	T-28	60,000	60	2000	—
3000	H-9	T-9½	120,000	40	3000	—

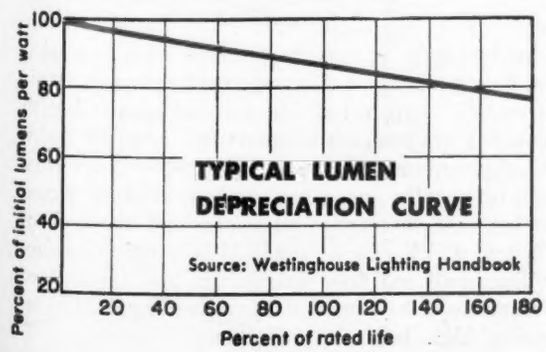
Source: IES Lighting Handbook
* Lamps listed are for general lighting purposes.
Other mercury lamps also available for special application.

STANDARD* MERCURY LAMPS

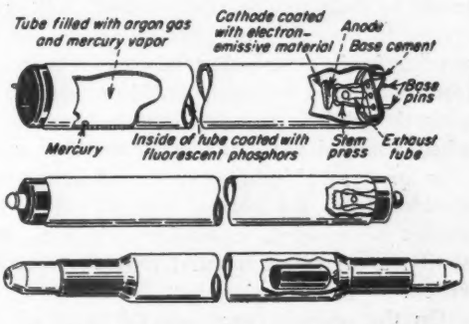
LIGHT SOURCES



EFFECT OF TEMPERATURE ON FLUORESCENT LAMPS
Source: Westinghouse Lighting Handbook



TYPICAL LUMEN DEPRECIATION CURVE
Source: Westinghouse Lighting Handbook



FLUORESCENT LAMP CATHODES
Source: IES Lighting Handbook

SELECTION OF LIGHTING SYSTEM

TYPES OF LUMINAIRES

LIGHT DISTRIBUTION CLASSIFICATION	LUMINAIRE DESCRIPTION
DIRECT (A)	a. Suspended
	b. Ceiling mounted
SEMI-DIRECT (B)	c. Recessed
	d. Concealed (coffer and soffit)
GENERAL DIFFUSE (C)	e. Luminous elements
	f. Architectural elements
SEMI-INDIRECT (D)	g. Pedestal or floor mounted
	h. Wall mounted
INDIRECT (E)	i. Cove lighting
	j. Special ornamental

ILLUMINATION LEVELS FROM TYPICAL LUMINAIRES

LUMINAIRE TYPE	LAMP TYPE	FOOTCANDLES PER WATT PER SQUARE FOOT*
Suspended indirect	Incandescent	2 to 4
Shielded direct recessed	Incandescent	3 to 5
General diffuse	Incandescent	4 to 6
Open bottom direct	Incandescent	5 to 7
Suspended indirect	Fluorescent†	6 to 10
Shielded direct	Fluorescent†	8 to 12
Open bottom direct	Fluorescent†	10 to 14
Series and multiple thin fluorescent tubing and 40-watt, 60-inch (T-17) lamps in rooms with high-reflectance walls and ceilings		12 to 16

*Footcandles listed are those which may be expected after two years of average maintenance. The lower figures apply to small rooms finished in dark colors with poor maintenance.
†Any kind, preheat or cold cathode.
Source: IES Lighting Handbook

DESIRABLE REFLECTION FACTORS

CEILINGS	75-85%
WALLS	50-60%
DESK TOPS	25-35%
FLOORS	15-30%

Source: Westinghouse Lighting Handbook

THE type of lighting system which will meet the requirements for a specific lighting problem will be controlled to considerable extent by the lighting result which is desired. Ornamental and decorative considerations will also play a part, especially the color and finish of the interior.

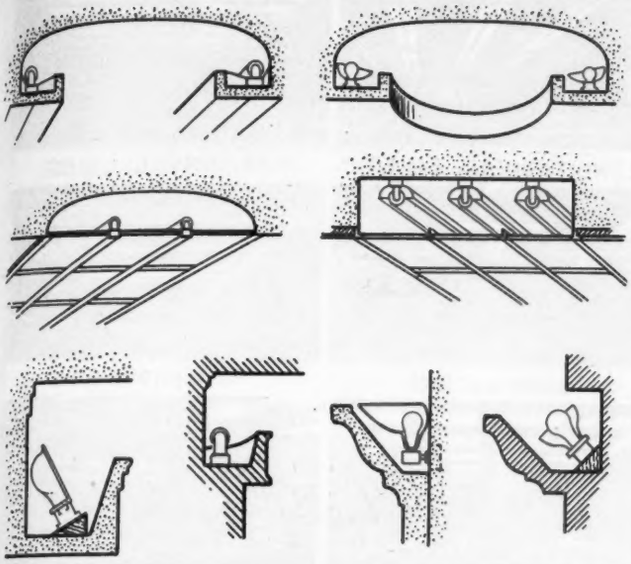
Lighting systems are classified according to type of light distribution, and to type of luminaires. Current techniques in solving lighting problems are generally to use more than one type of lighting system on each project. For example, general lighting in stores may be either of the five types of light distribution, from totally direct to totally indirect, and accent lighting may be superimposed on the general lighting system to provide highlights on feature displays. Current practice for lighting industrial areas is to use direct lighting from suspended, ceiling mounted or recessed luminaires for general lighting, and to provide supplementary lighting when required with supplementary type reflector units.

In any type of lighting system all light sources should be shielded from the normal field of view. Reflected glare should be avoided, especially in offices, classrooms and similar areas where specular reflection interferes with easy vision.

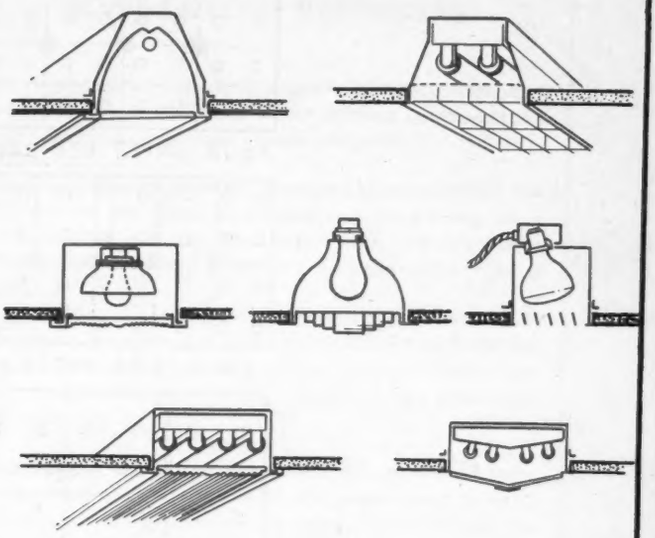
On the opposite page several types of luminaires and lighting equipment are shown. The list is not intended to be complete. However, it does indicate the wide range of types of luminaires and equipment which are available. For example, indirect lighting may be obtained with suspended luminaires, floor pedestals, wall urns, cove lighting or architectural elements. Direct lighting may be obtained with ceiling mounted or suspended luminaires, recessed units, concealed equipment or luminous and architectural elements.

In relighting installations, capacity of the existing wiring may limit both the footcandle intensities and the type of lighting system which may be used. Where reflection factors of ceiling, wall and floor finishes are low, the desired lighting result may be obtained by repainting in lighter colors having high luminous reflectance.

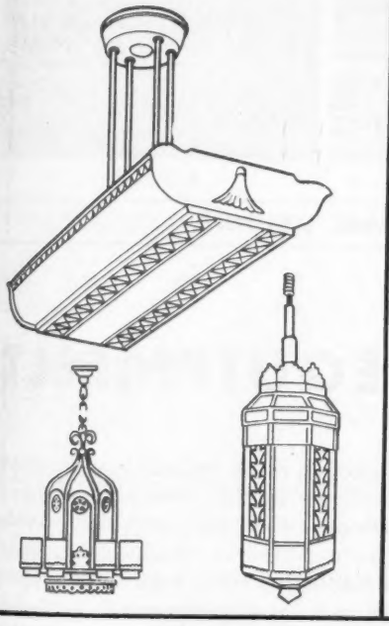
CONCEALED LIGHTING EQUIPMENT



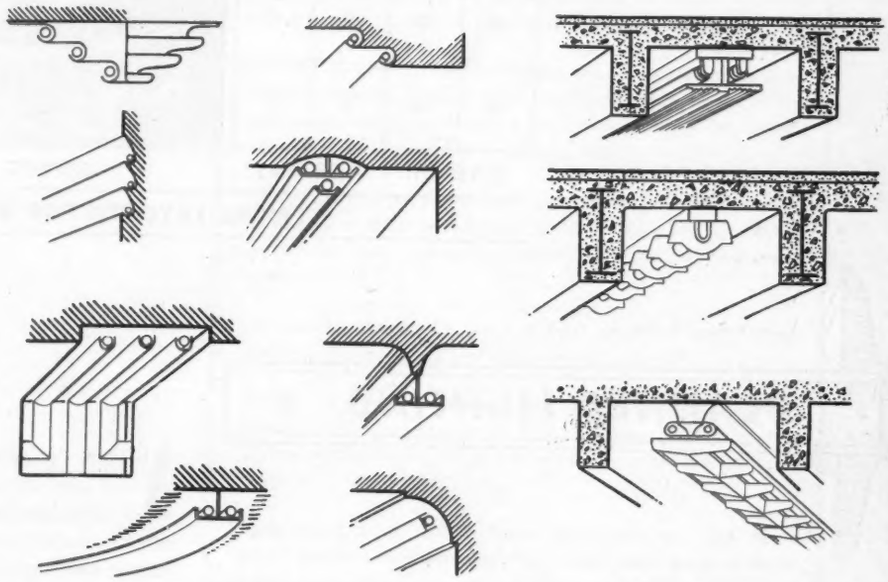
RECESSED LUMINAIRES



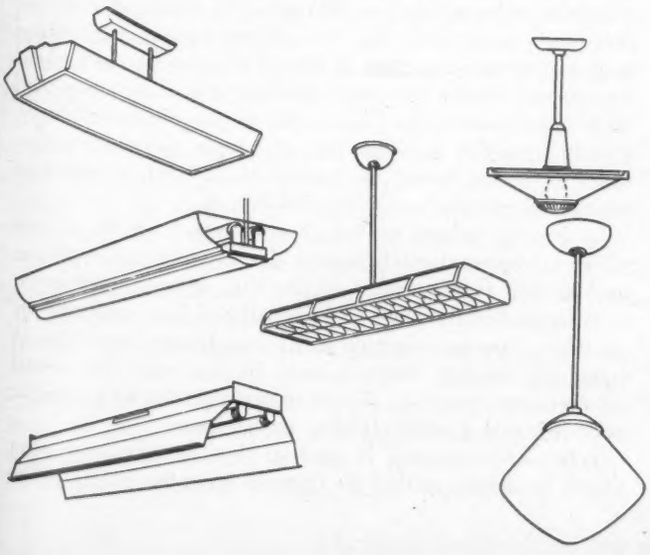
ORNAMENTAL LUMINAIRES



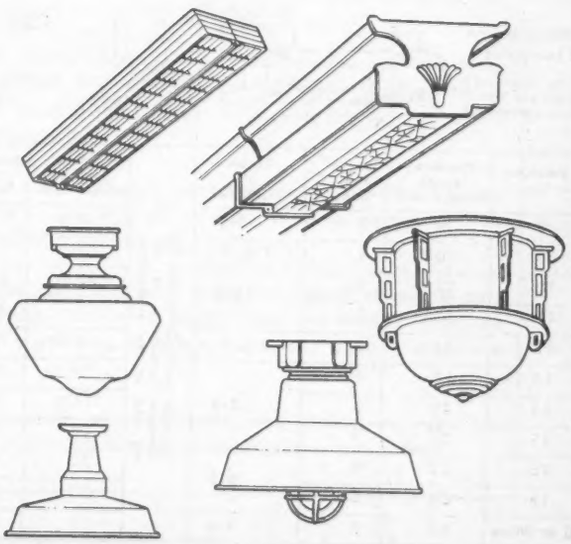
ARCHITECTURAL ELEMENTS

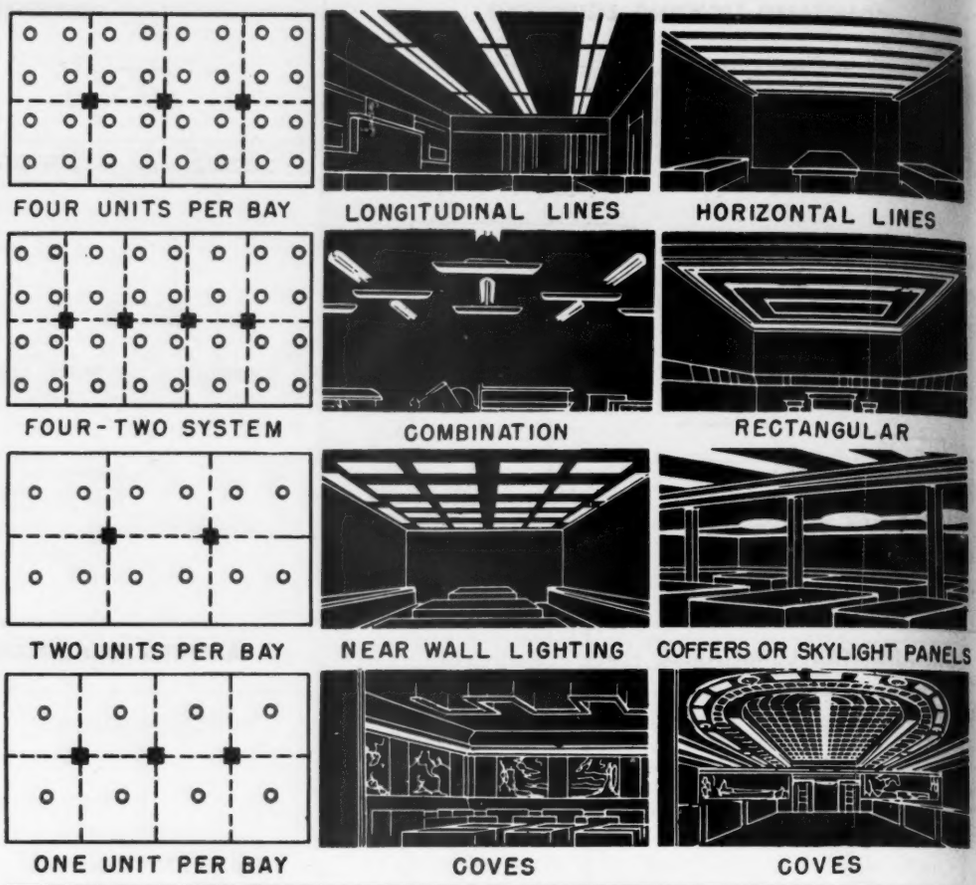


SUSPENDED LUMINAIRES



CEILING MOUNTED LUMINAIRES





TYPICAL LAYOUTS FOR GENERAL LIGHTING

LUMINAIRE SPACINGS

Light Distribution →	Indirect	Semi-Indirect	Semi-Direct	Direct
Mounting Height of Luminaire / Ceiling Height for Indirect and Semi-Indirect Luminaires				

All Dimensions in Feet	Maximum Spacing Between Units	Spacing* from Walls	Length of Suspension	The usual spacing is less than the maximum permissible to suit the room or bay arrangement.	Maximum Spacing Between Units	Spacing* from Walls
8	9	3	1-3		7½	3
9	10½	3	1½-3		9	3
10	12½	3½	2-3		10½	3½
11	13½	3½			12	3½
12	15	4	2½-4		13½	4
13	17	4	3-4		15	4
14	19	5			16½	5
15	20	5			18	5
16	22	6	4-5		20	6
18	24	6			22	6
20 or More	28	7	4-6		25	7

*These spacings apply where desks and benches are next to wall, otherwise one-half the spacing between units its satisfactory.

Source: General Electric Company

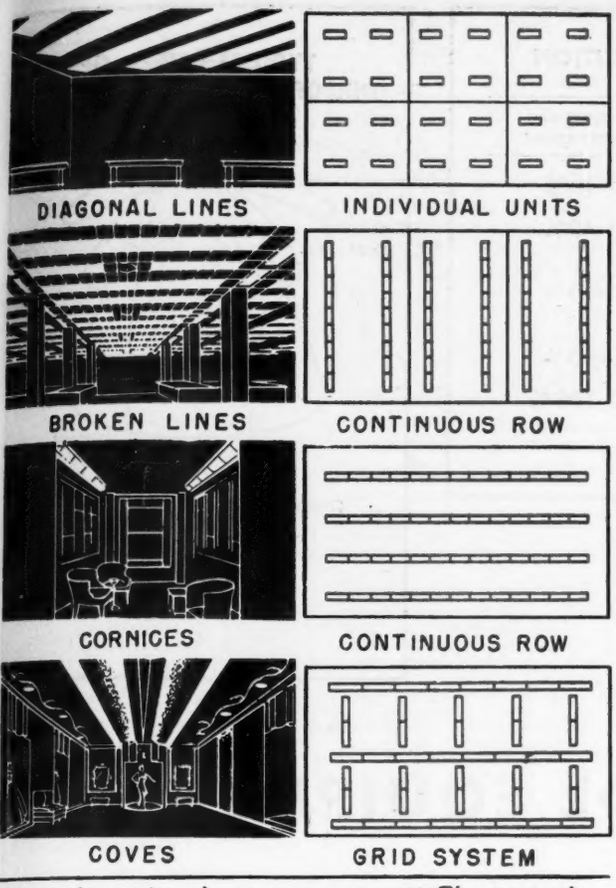
EQUIPMENT

AFTER the desired lighting result for a lighting problem has been determined, and the light source and lighting system has been selected, it is a relatively simple problem to locate the luminaires or reflector equipment. Fifteen simple rules are listed on the following page, under "Some Layout Reminders", to aid the lighting engineer in this task. Typical layouts used for general lighting are also shown in the illustrations at the top of these two pages.

Luminaire spacings are controlled by the light distribution of the luminaires, bay area dimensions, and mounting height of units. The table at the left may be used as a guide for spacing typical luminaires having light distribution patterns approximately as shown. When bay dimensions vary greatly from the spacings indicated for a specific type fixture, the units should be located closer and on spacings which will provide a symmetrical layout.

In general, when individual units are used, bay areas which are approximately square should be lighted with one unit located in the center of the bay, or with four units, each located in the center of each of the four quadrants of the bay. Spacing between units in adjacent bays should equal the spacing between units in the same bay. Such arrangements provide a degree of architectural or geometric harmony, and a more pleasing appearance.

When cove lighting is used to light an area, the cove should be located so that the distance from the ceiling to the



LAYOUT

cove is at least one-half the width of the ceiling being lighted by the cove. A ratio of three-fourths-to-one, or one-to-one, is preferred. The cove should be wide enough and deep enough to completely conceal the equipment below a sight line drawn across the top of the cove from a point six feet above the floor on the opposite wall line. Concentrating type reflectors with the center-line of the reflector axis pointing to the center of the ceiling or beyond the center is desirable in most cases, especially when the cove is located fairly close to the ceiling.

If coffers or soffits are used to light an area, the area of the lighted element should be from one-fourth to one-half the floor area, for intensities up to 20 footcandles. For higher intensities, up to 50 footcandles, it is desirable that the coffers or soffits cover practically all of the ceiling area. Otherwise, the lighted surfaces become sufficiently bright to cause glare. Louvered ceilings are now being used successfully for intensities of 50 footcandles and above, with direct lighting reflectors being mounted above the louvers and properly spaced to light the louvers uniformly. The louvers shield the light sources and present a low surface brightness when viewed normally from below. Louvered ceilings permit reflected glare, however, except when intensities are 50 footcandles or above, and except when low-brightness light sources are used. Reflected glare should be kept at a minimum on all types of installations.

SOME LAYOUT REMINDERS

The reason a customer buys a good lighting system is to get an adequate and comfortable lighting result—not just to buy lighting fixtures, lamps, conduit and wiring.

Lighting equipment selected should be appropriate for the interior and the visual tasks involved. Appearance, direct glare, reflected glare, shadows, maintenance, and light output efficiency are all factors in selecting the luminaires or lighting equipment.

The layout should fit the structural details of the building. If plans and drawings are not available, survey the interior and note location of columns, beams, obstructions and other architectural features.

Conventional layouts with symmetrical spacing of units are preferred, with units parallel and perpendicular to walls. Fancy geometrical patterns may be suitable in some cases, but should be avoided generally.

Many fluorescent luminaires are longer than the nominal length of the lamps they employ. When continuous row units are employed, fixture dimensions should be checked carefully.

Continuous row fluorescent units usually look better than individual units located with small spaces between adjacent ends. Economies in wiring and installation costs are usually effected with continuous row mounting, too.

Some manufacturers make the same standard model luminaire in different lengths. These details should be checked so that the most appropriate length units can be used in all locations.

Luminaires should be kept a foot or more away from walls, so that rooms will not look crowded with units.

There is a trend to recessed and ceiling-mounted installations. Check to see that use of such equipment will not produce uncomfortably dark ceilings and excessive brightness ratios in the field of view.

Suspended units which direct light both up and down often produce the best lighting result most economically. Check the suspension length carefully, and limit it to the value which gives reasonably uniform ceiling brightness.

Luminaire spacings should be used which produce uniform illumination and prevent bad shadows.

Layout should be planned to permit additional units to be added later. This will permit an increase in lighting intensity without spoiling the symmetry or architectural harmony of the initial installation.

Plan the maintenance program along with the lighting layout. Be sure that all units are easily accessible, and are designed to be cleaned easily and quickly.

Consider the finish and reflection factor of ceiling and side walls. Recommend proper colors and finishes to provide proper surrounding brightness conditions which promote eye comfort.

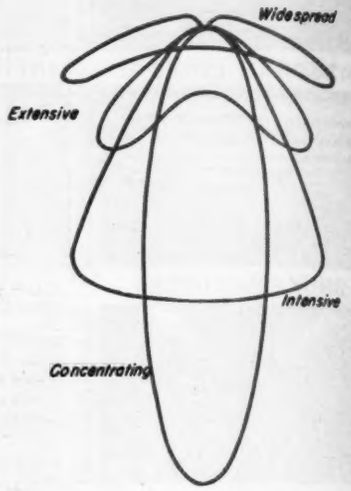
Double check all calculations and details, to insure the proper number of units and the final *lighting result* desired.

CLASSIFICATION OF LIGHT DISTRIBUTION

System	Upward Component	Downward Component
Indirect	90-100%	0-10%
Semi-Indirect	60-90%	10-40%
General Diffuse / Direct-Indirect	40-60%	40-60%
Semi-Direct	10-40%	60-90%
Direct	0-10%	90-100%

Source: IES Lighting Handbook

TYPICAL TYPES OF DIRECT LIGHT DISTRIBUTION



PLANNED LIGHTING

LIGHT CONTROL EQUIPMENT

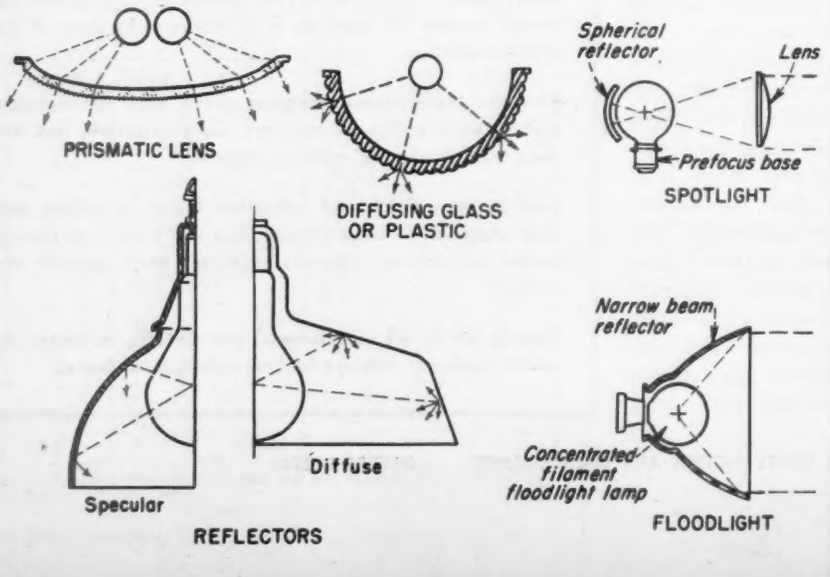
LIGHT control devices are selected by equipment manufacturers for their standard production models of luminaires and reflector equipment. However, it is the lighting engineer's responsibility to his customer to select light control devices which are best suited for each specific application. These devices may be incorporated in luminaires, or, in some instances, may be combined with architectural elements of the building, or in furniture, store fixtures and other interior furnishings. Reflectors installed in wall urns, floor pedestals, coves, and luminous or architectural elements are examples.

Nine examples of light reflection from various types of surfaces are shown in the illustration at the top of the next page. Application of these laws of reflection are shown in reflector equipment illustrated below. Light may also be controlled by refraction or diffusion through prismatic lenses or diffusing glass or plastics, and by shielding, as with louvers.

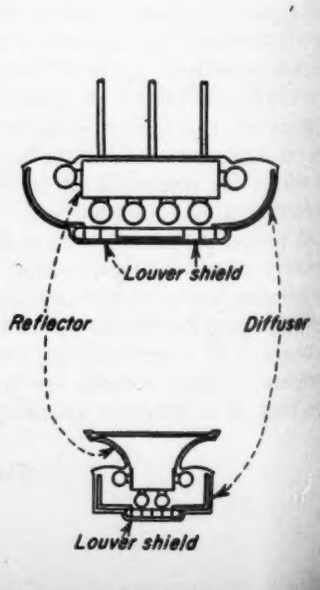
Light distribution from luminaires has been classified into five types by the International Commission on Illumination (I.C.I.). These five classifications are defined by the percentage of light directed upward or downward from the center of the luminaire. Percentage values for each classification are given in the Table above.

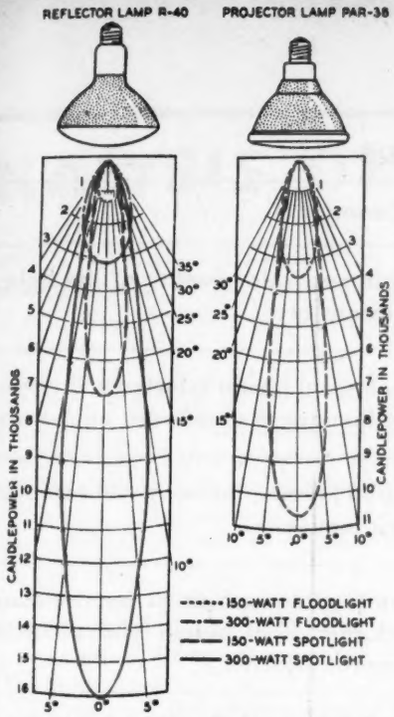
Important considerations in the selection of light control devices include efficiency, durability, ease of maintenance and attractive appearance. Reflectors with specular surfaces are used to obtain accurate light control. Concentrated and intensive light distribution require specular or semi-polished reflectors.

LIGHT CONTROL DEVICES



IN LUMINAIRES

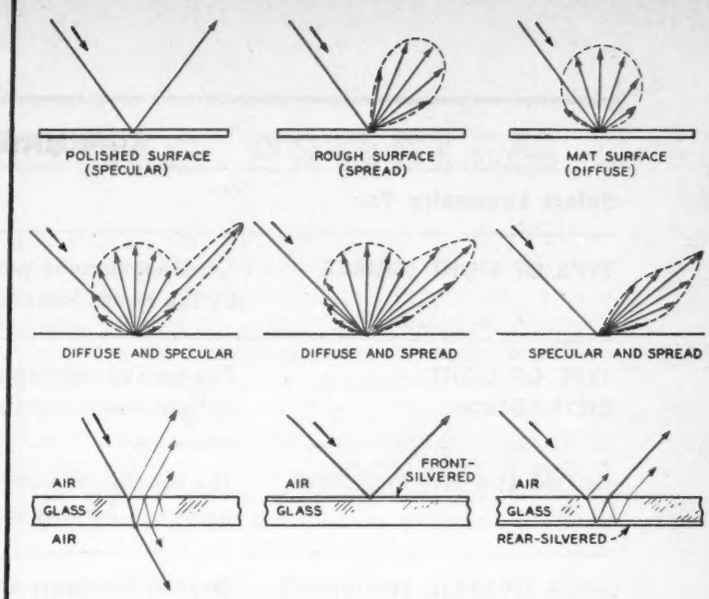




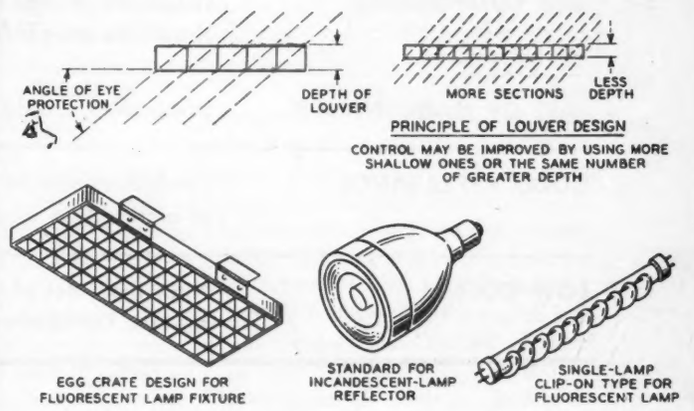
Footcandles at Various Distances From Lamps

	DISTANCE FROM LAMP							
	5 Feet		10 Feet		15 Feet		20 Feet	
	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot
Projector Spot	3′	420	6′	105	9′	47	12′	26
Projector Flood	6′	100	12′	25	18′	11	24′	6
150-watt Reflector Spot	3′	280	6′	70	9′	31	12′	17
150-watt Reflector Flood	6′	48	12′	12	18′	5	24′	3
300-watt Reflector Spot	3′	640	6′	160	9′	71	12′	40
300-watt Reflector Flood	7′	120	14′	30	21′	13	28′	8

LAMPS WITH INTEGRAL REFLECTOR



TYPES OF REFLECTION FROM VARIOUS SURFACES


ANGLE OF EYE PROTECTION
DEPTH OF LOUVER
MORE SECTIONS
LESS DEPTH
PRINCIPLE OF LOUVER DESIGN
CONTROL MAY BE IMPROVED BY USING MORE SHALLOW ONES OR THE SAME NUMBER OF GREATER DEPTH
EGG CRATE DESIGN FOR FLUORESCENT LAMP FIXTURE
STANDARD FOR INCANDESCENT-LAMP REFLECTOR
SINGLE-LAMP CLIP-ON TYPE FOR FLUORESCENT LAMP

LOUVERS CONTROL LIGHT BY SHIELDING

Sources: IES Lighting Handbook

Medium spread light distribution is produced by semi-mat aluminum or silver-mirrored glass reflectors. Diffuse light distribution is produced by mat aluminum finished reflectors, silver-mirrored glass reflectors, porcelain enameled steel reflectors, or baked enamel reflecting surfaces. Mat surface ceilings, either painted with flat paint or unpainted plaster or acoustical material, produces a diffuse reflection.

A wide range of light distribution patterns, both symmetrical and asymmetrical, can be produced by silver-mirrored glass reflectors by change in contour of the reflectors. Such reflectors are particularly well adapted for use with incandescent and mercury vapor light sources where the light is confined to an approximate point source. These reflectors are less effective with fluorescent line sources where the source is one inch or more in diameter. The cost usually becomes prohibitive for the amount of control afforded.

Prismatic glass reflectors and refractors control the light distribution over a complete range from intensive to wide spread distribution through prismatic reflection or refraction. Such reflectors and refractors are highly durable and efficient. They are well-suited for incandescent and mercury vapor light sources, and have also been designed for use with fluorescent lamps.

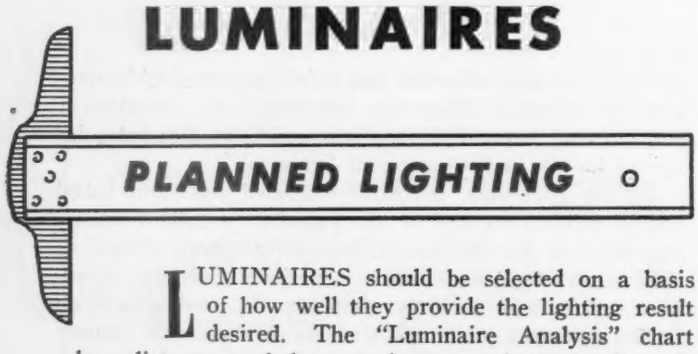
Diffuse aluminum, porcelain enameled steel and baked enamel finishes on steel or aluminum are excellent reflecting surfaces for fluorescent luminaires where diffuse or wide spread light distribution is desired. Specular aluminum reflectors in parabolic shape can be used with small diameter fluorescent lamps, such as slimline, cold cathode and T-8 lamps, to produce intensive distribution.

Several incandescent lamps are now available with integral reflector, such as the R-40 reflector spot and reflector flood, PAR-38 projector spot, and projector flood, and bowl-silvered lamps in a wide range of sizes and wattages. The R-40 and PAR-38 lamps are used primarily for display and accent lighting in stores, or where a concentrated beam of light is needed. Bowl-silvered lamps are used in suspension-type luminaires, containing a shielding bowl or rings, to provide indirect lighting for offices, reception rooms, stores, classrooms and similar areas.

LUMINAIRE ANALYSIS

Select Luminaire For	Comments
TYPE OF LIGHT SOURCE	Consider lumens per watt, size of lamps, color quality of the light produced by the lamp, lamp life and replacement cost.
TYPE OF LIGHT DISTRIBUTION	The type of lighting system and equipment layout selected will control the type of light distribution required for the luminaires or reflector equipment.
INITIAL LUMENS REQUIRED	The spacing of outlets and the desired lighting intensity will establish the light output in lumens required for each luminaire.
HIGH OVERALL EFFICIENCY	Overall efficiency of luminaires varies from a high of approximately 90 per cent downward. Fixture manufacturers' light output and distribution curve data should be consulted for luminaires selected.
HIGH QUALITY MATERIALS AND COMPONENTS	Reflectors should have permanent type reflecting surface. Diffusing media should be of high quality and present evenly lighted surface. Gauge of metals should be proper for necessary rigidity. Proper ventilation is important.
EASE OF MAINTENANCE	Luminaires should be easy to clean and relamp.
GOOD APPEARANCE	Luminaires should present a good appearance and harmonize with the interior or architecture where used. Plain, simple lines are usually preferred.
LOW COST	High first cost of equipment may prevent the installation of a good lighting system. Luminaires should be reasonably priced.

SELECTION OF LUMINAIRES



LUMINAIRES should be selected on a basis of how well they provide the lighting result desired. The "Luminaire Analysis" chart above lists some of the more important factors to be considered. There are, of course, other factors which should also be taken into account, depending on the type of luminaires involved and the type of area to be lighted.

Luminaires used for general lighting purposes should provide a high overall efficiency. They should also be designed to provide the necessary comfort in vision. That is, the light sources should be shielded to prevent direct glare in the normal field of vision. They should also prevent or minimize reflected glare, especially those selected to light offices, classrooms and drafting rooms.

Depending on the type of area to be lighted, it is often necessary to first select the type of luminaire which is to be used, and then plan the equipment layout around the light distribution of the luminaires selected. This procedure has the advantage of making it possible to use a particular type of luminaire and to adapt the layout to meet the necessary conditions imposed by the size and light distribution characteristics of the luminaire. When the appearance of the physical layout of luminaires is of greater importance, the equipment layout should be made first, and luminaires then selected to meet these requirements.

How luminaires will affect the appearance of the lighted room is an important factor. Highly ornate luminaires are less in favor today. The trend is toward plain, simple lines in exposed or recessed equipment. Many customers prefer recessed troffers or individual incandescent units, which have the effect of making the area appear larger.

Reflector materials and finishes are important. The materials should be such that the reflecting surface is permanent and will not deteriorate excessively from heat and repeated cleanings. Finishes should be proper for producing the type of light distribution required.

The electrical characteristics of auxiliaries used in fluorescent luminaires are also important. Ballasts should be of high power factor type, and ballasts, starter switches, lampholders and other electrical devices should be built to conform to underwriters' specifications.

ANALYSIS OF LIGHTING PROBLEM

PLANNED LIGHTING layouts are based on making a complete analysis of the lighting problems involved on each project, and then making a plan on which all lighting data are shown.

Factors involved in making an analysis of the lighting problem include the study of the seeing tasks which will obtain, the analysis of the desired lighting result, and the consideration of all physical properties of the area to be lighted. Physical considerations include area dimensions, ceiling heights, reflection factors of ceilings, walls, floors and furnishings, the degree of light interference by machines, furniture, workers, etc., and the wiring capacity required or existing. Physical considerations also include structural elements and architectural detail, especially where recessed or concealed equipment is involved.

Planning the lighting for new construction offers greater freedom in the choice of the lighting system, luminaires or equipment, wiring layout and control than does planning the relighting of an existing structure. The lighting designer should work closely with the architect and decorator in either case. In new construction the architect will be able to coordinate structural details with lighting details, thus providing better appearance in the final lighting result, and greater satisfaction for all concerned.

On relighting projects one of the first considerations is the capacity of the existing wiring system. Where the wiring system is inadequate, the lighting designer should provide a solution for the revamping of the wiring on an economical basis which will insure adequate capacity for the lighting system which he recommends. He should also carefully survey all existing srtuctural details and be sure the lighting system he recommends is feasible and practical, and that the luminaires and equipment can be installed in the locations indicated.

The ratio of the light produced by the lamps to the amount of light which ultimately reaches the working plane is a measure of efficiency of the lighting system. This is commonly referred to as the "Coefficient of Utilization". Tables on the following pages show coefficients of utilization for several types of luminaires under varying conditions of room sizes and reflection factors for ceilings and side walls. These data make it possible to predetermine fairly accurately the footcandle intensities which may be expected under a specific set of conditions. In making an analysis of the lighting problem, one of the objects is to summarize and list all information required to make these preliminary lighting calculations.

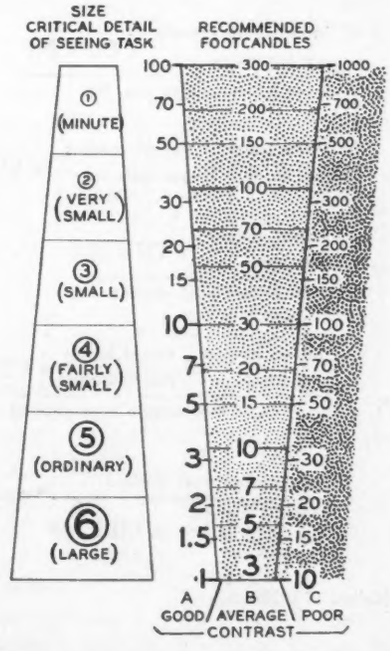
While it is important to recommend specific levels of illumination (usually the minimum found practical for specific types of work through experience and tests, or higher) and to provide the necessary number of luminaires of correct type to provide these levels, there are also other factors which it is important to consider. One such factor is the matter of brightness and brightness contrast. The brightness of luminaires, or of lighted elements including the ceiling when an indirect lighting system is used, should be kept at a minimum. These areas of brightness should be surrounded by areas whose brightness contrast is not great, as such conditions constitute glare. Care should be taken when luminaires or equipment are recessed flush in the ceiling, so that the contrast between the ceiling and the recessed units is within comfort limits. On recessed installations the ceilings should be finished white or in a very light color having a high reflection factor. Light walls, floors and furniture are also desirable on recessed installations, as these will usually reflect enough light back to the ceiling to prevent undue contrast. The influence of contrast on recommended intensities is shown below.

DIFFUSE REFLECTION FACTORS

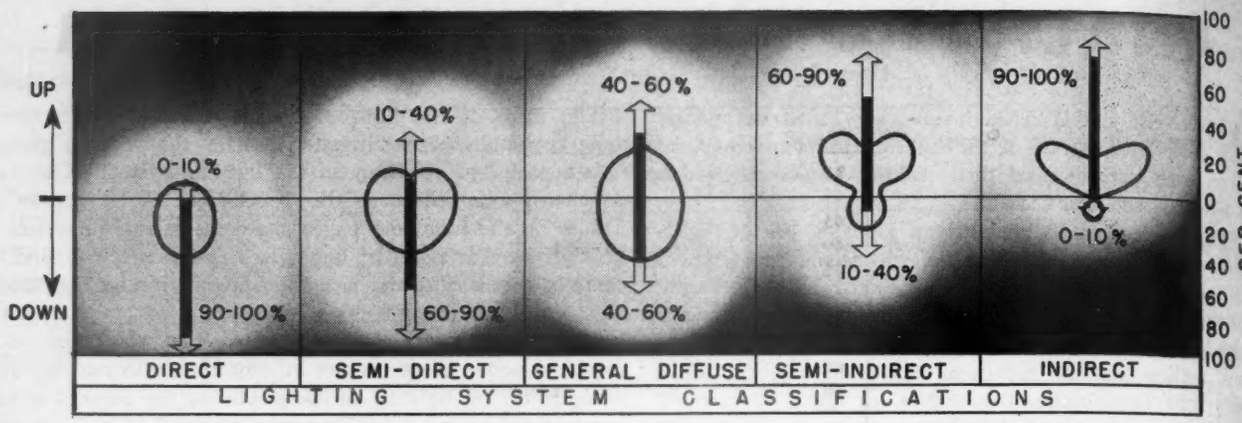
Color	Average Reflection Factor	Color	Average Reflection Factor
White	.88	MEDIUM	
		Blue-green	.54
		Yellow	.65
		Buff	.63
VERY LIGHT		Grey	.61
Blue-green	.76		
Cream	.81	DARK	
Blue	.65	Blue	.08
Buff	.76	Yellow	.50
Grey	.83	Brown	.10
		Grey	.25
		Green	.07
		Black	.03
LIGHT			
Blue-green	.72	WOOD	
Cream	.79	FINISHES	
Blue	.55	Maple	.42
Buff	.70	Walnut	.16
Grey	.73	Mahogany	.12

Source: Westinghouse "Data for Designing Interior Illumination" Bulletin

INFLUENCE OF SIZE AND CONTRAST



Source: IES Lighting Handbook



PLANNED LIGHTING

LIGHTING CALCULATIONS

FORMULAS FOR GENERAL LIGHTING DESIGN

$$\text{Average lumens reaching work plane} = \text{total initial lamp lumens} \times CU \times MF$$

$$\text{Average footcandles} = \frac{\text{total initial lamp lumens} \times CU \times MF}{\text{Area of room (sq. ft.)}}$$

$$= \frac{\text{initial lumens per lamp} \times CU \times MF}{\text{Area per lamp (sq. ft.)}}$$

$$= \frac{\text{initial lamp lumens per luminaire} \times CU \times MF}{\text{Area per luminaire (sq. ft.)}}$$

$$= \text{total watts per sq. ft.} \times \text{overall lumens per watt} \times CU \times MF$$

$$\text{Area per lamp (sq. ft.)} = \frac{\text{initial lumens per lamp} \times CU \times MF}{\text{Footcandle level desired}}$$

$$\text{Area per luminaire (sq. ft.)} = \frac{\text{initial lumens per lamp} \times \text{no. of lamps per luminaire} \times CU \times MF}{\text{Footcandle level desired}}$$

$$\text{Total Watts per sq. ft.} = \frac{\text{Footcandle level desired}}{\text{overall lumens per watt}} \times CU \times MF$$

CU = Coefficient of Utilization

MF = Maintenance Factor

THERE are two methods for calculating the quantity of light for an area, the *Lumen* method and the *Point-by-Point* method. The *Lumen* method is used here, as it is relatively simple and has been generally adopted for calculating general lighting intensities. It is accurate to the extent that each factor in the formulas, given at the left, is evaluated.

Average "in service" footcandles of general illumination can be estimated for a room, by inserting proper values in the formula at left. The procedure is as follows:

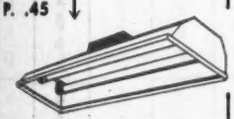
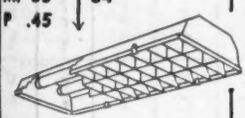
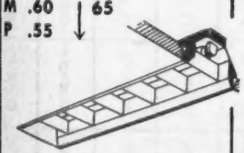
1. Determine the "total initial lamp lumens" by multiplying the number of lamp lumens per lamp by the number of lamps (See Tables under "Selection of Light Sources").
2. Determine area of room in square feet and room index from "Room Index Table".
3. Determine the coefficient of utilization (CU in the formula) for the type of luminaire recommended, using the "Coefficient of Utilization for Typical Luminaires" Table (See the next two pages).
4. Determine the maintenance factor (MF in the formula) for the type of fixture recommended, using the "Coefficient of Utilization for Typical Luminaires" Table, and based on whether maintenance will be "good", "medium" or "poor".
5. Apply these values in the second formula at the left. The result will be the calculated "average footcandles" which may be expected after the luminaires have been installed and in use long enough for dust, lamp life and dirt to depreciate the light output to the value estimated.

Coefficients of utilization vary for different luminaires having different light distribution characteristics. Typical types of luminaires have been selected for use in the "Coefficient of Utilization" Tables. Similar data should be obtained direct from fixture manufacturers for other luminaires having different light distribution or efficiency characteristics.

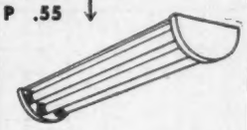
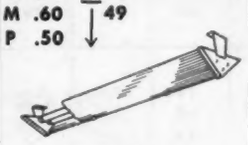
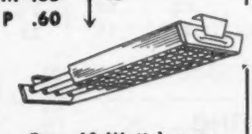
Analysis of the Room Index Table will show that large areas use light more efficiently than do small areas, because the ratio of wall area to floor area is less in larger rooms.

COEFFICIENTS OF UTILIZATION FOR TYPICAL LUMINAIRES

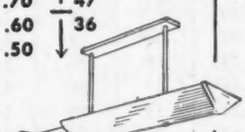
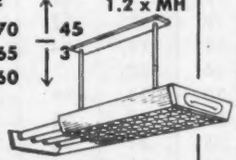
DIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .65 P .55 — 1 x MH — 0 to 79 R.L.M. Dome Reflector		J	.37	.31	.36	.31
		I	.45	.41	.45	.40
		H	.49	.45	.49	.45
		G	.53	.49	.53	.49
		F	.56	.53	.55	.52
		E	.61	.58	.60	.57
		D	.66	.63	.64	.62
		C	.67	.65	.66	.64
		B	.71	.68	.69	.67
		A	.72	.70	.71	.68
MF G .75 M .60 P .50 — 1 x MH — 0 to 75 Aluminum High-Bay Reflector, Medium Spread		J	.40	.36	.39	.36
		I	.48	.45	.47	.44
		H	.52	.50	.51	.49
		G	.55	.53	.55	.52
		F	.58	.56	.56	.55
		E	.62	.60	.61	.59
		D	.66	.63	.64	.62
		C	.67	.65	.66	.64
		B	.69	.67	.67	.65
		A	.70	.68	.69	.67
MF G .70 M .60 P .50 — 0.8 x MH — 0 to 53 Enclosed-Lens-Plate Distributing Type		J	.25	.22	.24	.22
		I	.31	.28	.29	.28
		H	.34	.31	.32	.31
		G	.36	.33	.34	.33
		F	.38	.35	.36	.34
		E	.40	.39	.39	.37
		D	.43	.41	.42	.40
		C	.45	.43	.44	.41
		B	.48	.45	.47	.43
		A	.50	.47	.48	.46
MF G .65 M .55 P. .45 — 1 x MH — 0 to 79  Two 40-Watt Lamps		J	.38	.32	.37	.32
		I	.47	.42	.46	.41
		H	.51	.47	.50	.47
		G	.55	.51	.54	.51
		F	.58	.54	.57	.53
		E	.63	.60	.62	.59
		D	.68	.64	.66	.64
		C	.70	.67	.68	.65
		B	.73	.70	.71	.68
		A	.74	.72	.72	.70
MF G .65 M. 55 P .45 — 0.9 x MH — 0 to 64  Two 40-Watt Lamps With Louvers,		J	.33	.28	.32	.28
		I	.39	.36	.39	.35
		H	.43	.40	.42	.40
		G	.46	.43	.45	.43
		F	.48	.46	.47	.45
		E	.52	.50	.51	.49
		D	.55	.53	.54	.52
		C	.57	.55	.56	.53
		B	.59	.57	.57	.56
		A	.60	.58	.59	.57
MF G .70 M .60 P .55 — 0.8 x MH — 0 to 65  Troffer with Louvers		J	.32	.28	.32	.28
		I	.40	.36	.39	.35
		H	.43	.39	.42	.39
		G	.46	.43	.45	.43
		F	.48	.45	.47	.45
		E	.52	.50	.51	.49
		D	.56	.54	.55	.53
		C	.57	.55	.56	.54
		B	.60	.58	.59	.57
		A	.61	.59	.60	.58
MF G .75 M .65 P .55 — 1 x MH — 8 to 77 Bare Lamp with White Reflecting Surface		J	.32	.27	.32	.26
		I	.40	.35	.39	.34
		H	.44	.39	.43	.39
		G	.48	.43	.46	.42
		F	.52	.47	.50	.46
		E	.57	.52	.55	.51
		D	.62	.56	.59	.55
		C	.65	.59	.62	.57
		B	.69	.63	.65	.61
		A	.71	.66	.67	.63

SEMI-DIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .65 P .55 — 1 x MH — 25 to 60  Exposed Lamps		J	.27	.25	.26	.22
		I	.35	.29	.33	.28
		H	.38	.34	.36	.32
		G	.43	.38	.40	.36
		F	.46	.41	.43	.39
		E	.50	.46	.47	.43
		D	.55	.50	.51	.47
		C	.58	.53	.53	.49
		B	.62	.57	.57	.53
		A	.64	.60	.59	.55
MF G .70 M .60 P .50 — 1.2 x MH — 18 to 49  Ceiling Type Two 40-Watt Lamps		J	.24	.20	.23	.19
		I	.30	.26	.28	.24
		H	.33	.29	.31	.28
		G	.36	.32	.34	.31
		F	.39	.35	.36	.33
		E	.42	.39	.40	.37
		D	.46	.43	.43	.40
		C	.48	.45	.44	.42
		B	.51	.48	.47	.45
		A	.52	.50	.49	.46
MF G .70 M .65 P .60 — 0.9 x MH — 15 to 45  Four 40-Watt Lamps With Louvers, Ceiling Type		J	.24	.21	.21	.19
		I	.30	.27	.26	.24
		H	.32	.30	.29	.27
		G	.35	.33	.31	.29
		F	.38	.35	.32	.31
		E	.40	.38	.35	.35
		D	.43	.40	.38	.36
		C	.45	.42	.39	.37
		B	.47	.45	.41	.39
		A	.48	.46	.42	.40

GENERAL DIFFUSE LIGHTING

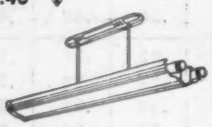
LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .70 P .65 — 1.2 x MH — 39 to 45 Totally Enclosed		J	.24	.19	.22	.18
		I	.29	.25	.27	.23
		H	.33	.28	.30	.26
		G	.37	.32	.33	.29
		F	.40	.36	.36	.32
		E	.45	.40	.40	.36
		D	.48	.43	.43	.39
		C	.51	.46	.45	.41
		B	.55	.50	.49	.45
		A	.57	.53	.51	.47
MF G .70 M .60 P .50 — 1.2 x MH — 47 to 36  Suspension Type Two 40-Watt Lamps		J	.26	.21	.22	.19
		I	.31	.26	.27	.24
		H	.34	.30	.30	.27
		G	.38	.34	.34	.30
		F	.41	.37	.36	.33
		E	.45	.41	.40	.36
		D	.49	.45	.42	.41
		C	.51	.48	.44	.44
		B	.55	.51	.47	.45
		A	.57	.53	.49	.46
MF G .70 M .65 P .60 — 1.2 x MH — 45 to 3  Suspension Type with Louvers Four 40-Watt Lamps		J	.26	.23	.23	.21
		I	.31	.28	.28	.26
		H	.35	.32	.31	.28
		G	.38	.35	.34	.31
		F	.41	.38	.36	.34
		E	.44	.42	.39	.37
		D	.48	.45	.42	.39
		C	.50	.49	.43	.41
		B	.53	.50	.46	.43
		A	.54	.52	.47	.45

MF = Maintenance Factor
G = Good
M = Medium
P = Poor
MH = Mounting Height

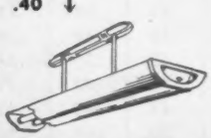
Source: IES Lighting Handbook

COEFFICIENTS OF UTILIZATION FOR TYPICAL LUMINAIRES

SEMI-INDIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .70 M .65 P .60 Totally Enclosed	1.2 x CH (66 / 20)	J	.20	.16	.16	.13
		I	.24	.20	.20	.17
		H	.28	.24	.23	.19
		G	.31	.27	.26	.22
		F	.34	.30	.28	.24
		E	.38	.34	.31	.27
		D	.42	.38	.34	.30
		C	.45	.41	.36	.32
		B	.49	.45	.39	.36
		A	.51	.47	.41	.38
MF G .60 M .50 P .40  Two 40-Watt Lamps	1.2 x CH (70 / 11)	J	.18	.14	.14	.11
		I	.22	.19	.17	.15
		H	.26	.22	.20	.17
		G	.29	.25	.22	.19
		F	.32	.28	.24	.21
		E	.35	.32	.27	.24
		D	.39	.35	.29	.26
		C	.42	.38	.31	.28
		B	.46	.42	.34	.31
		A	.48	.44	.36	.33

INDIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .65 M .55 P .45 Silvered Bowl	1.2 x CH (85 / 0)	J	.17	.14	.13	.11
		I	.21	.17	.16	.14
		H	.24	.21	.18	.15
		G	.27	.24	.21	.18
		F	.30	.27	.23	.20
		E	.33	.30	.25	.22
		D	.37	.33	.27	.25
		C	.39	.36	.29	.26
		B	.43	.40	.31	.30
		A	.45	.42	.34	.31
MF G .70 M. .60 P .50 Glass	1.2 x CH (79 / 3)	J	.16	.13	.12	.10
		I	.20	.16	.15	.13
		H	.23	.20	.17	.14
		G	.26	.23	.20	.17
		F	.29	.26	.22	.19
		E	.32	.29	.24	.21
		D	.36	.32	.26	.24
		C	.38	.35	.28	.25
		B	.42	.39	.30	.29
		A	.44	.41	.33	.30
MF G .60 M .50 P .40  Two 40-Watt Lamps	1.2 x CH (80 / 0)	J	.15	.11	.09	.08
		I	.19	.15	.12	.10
		H	.22	.19	.14	.12
		G	.26	.22	.17	.14
		F	.28	.24	.19	.16
		E	.32	.28	.21	.18
		D	.35	.31	.23	.21
		C	.38	.34	.25	.22
		B	.42	.39	.27	.25
		A	.43	.41	.29	.27

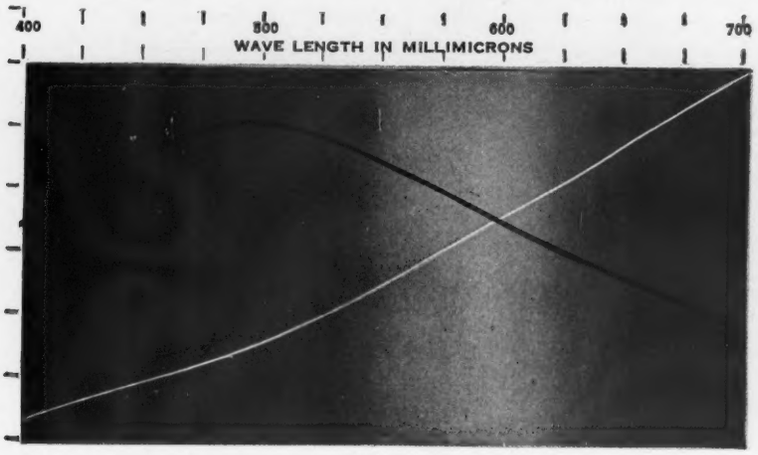
ROOM INDEX TABLE

Semi-indirect and Indirect Luminaires	CEILING HEIGHT (FEET) 9 to 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30
Direct, Semi-direct, General Diffuse, Direct-indirect Luminaires	MOUNTING HEIGHT ABOVE FLOOR (FEET) 7 to 7½	8 to 8½	9 to 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20
ROOM WIDTH* (Feet)	ROOM LENGTH* (Feet)	ROOM INDEX					
10 (9¼-10¼)	10-14	G	H	I	J	J	
	14-20	G	H	I	J	J	J
	20-30	F	G	H	I	J	J
	30-42	F	G	G	H	I	J	J
	42-60	E	F	G	H	I	J	J
12 (11-12½)	11-14	G	H	I	I	J	J	
	14-20	F	G	H	I	J	J	
	20-30	F	G	G	H	I	J	J
	30-42	E	F	G	H	I	J	J
	42-60	E	F	F	G	H	I	J
14 (13-15½)	13-20	F	G	H	H	I	J	J
	20-30	E	F	G	H	I	J	J
	30-42	E	F	F	G	H	I	J
	42-60	E	E	F	F	H	I	J
17 (16-18½)	16-20	E	F	G	H	I	J	J
	20-30	E	F	F	G	H	I	J
	30-42	D	E	F	G	H	H	J
	42-60	D	E	E	F	G	G	I
20 (19-21½)	20-30	D	E	F	G	H	I	J
	30-42	D	E	E	F	G	H	I
	42-60	D	D	E	E	F	G	I
	60-90	C	D	E	E	F	G	H
	90-140	C	D	D	E	F	F	H
24 (22-26)	22-30	D	E	E	F	G	H	I
	30-42	C	D	E	F	G	G	I
	42-60	C	D	D	E	F	G	H
	60-90	C	D	D	E	F	F	H
	90-140	C	C	D	E	E	F	G
30 (27-33)	27-42	C	D	D	E	F	G	H
	42-60	C	C	D	D	F	F	H
	60-90	B	C	C	D	E	F	G
	90-140	B	C	C	D	E	E	F
36 (34-39)	34-42	B	C	D	E	F	F	H
	42-60	B	C	C	D	E	F	G
	60-90	A	C	C	C	E	E	F
	90-140	A	B	C	C	D	E	F
42 (40-45)	40-60	A	B	C	C	E	F	G
	60-90	A	B	B	C	D	E	F
	90-140	A	B	B	C	D	E	E
	140-200	A	A	B	C	D	D	E
50 (46-55)	46-60	A	A	B	C	D	E	F
	60-90	A	A	B	C	C	D	F
	90-140	A	A	A	C	C	D	E
	140-200	A	A	A	C	C	D	E
60 (56-67)	56-90	A	A	A	B	C	D	E
	90-140	A	A	A	B	C	C	D
	140-200	A	A	A	B	C	C	D
75 (68-90)	68-90	A	A	A	A	B	C	D
	90-140	A	A	A	A	B	C	D
	140-200	A	A	A	A	B	B	C

*For areas with dimensions greater than those shown in the table, use the following procedure to determine the room index:

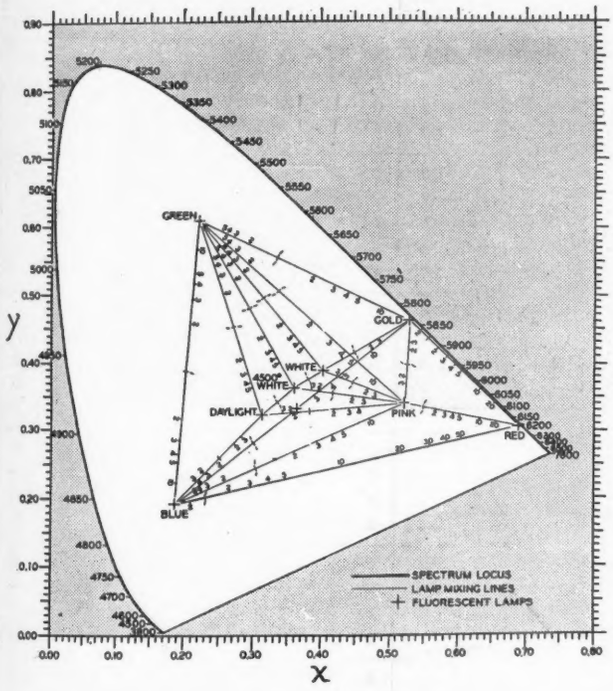
1. Divide length and width by some common number which reduces dimensions to values within limits of table.
2. Subtract 2½ ft from the mounting height (or ceiling height) and divide this dimension by same divisor used in step 1.
3. Add 2½ ft to reduced height dimension and select the room index from the above table according to these new dimensions.

CORRECT PAINT COLOR COMPLEMENTS LIGHT

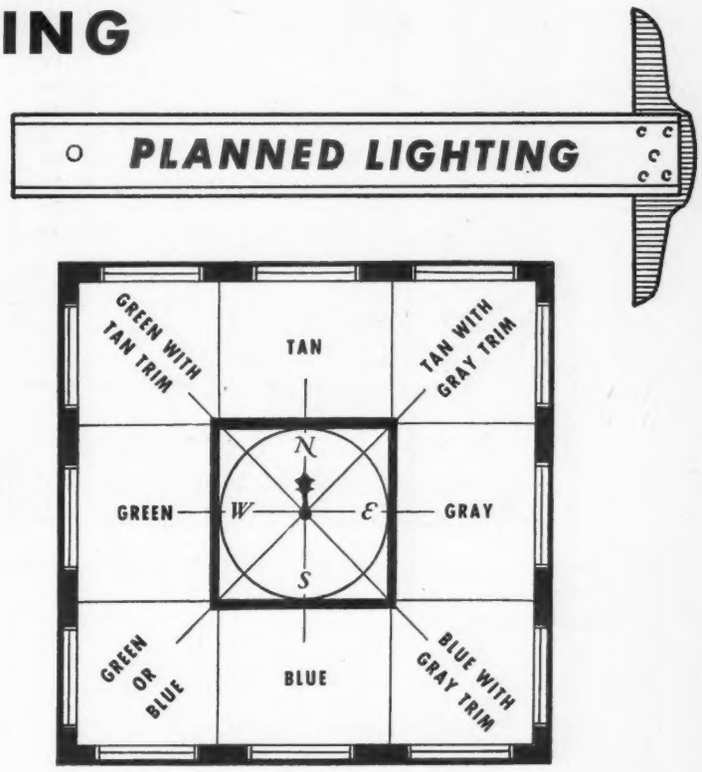


SOURCE: The Arco Company

COLOR IN LIGHTING



FLUORESCENT LAMP NOMOGRAM

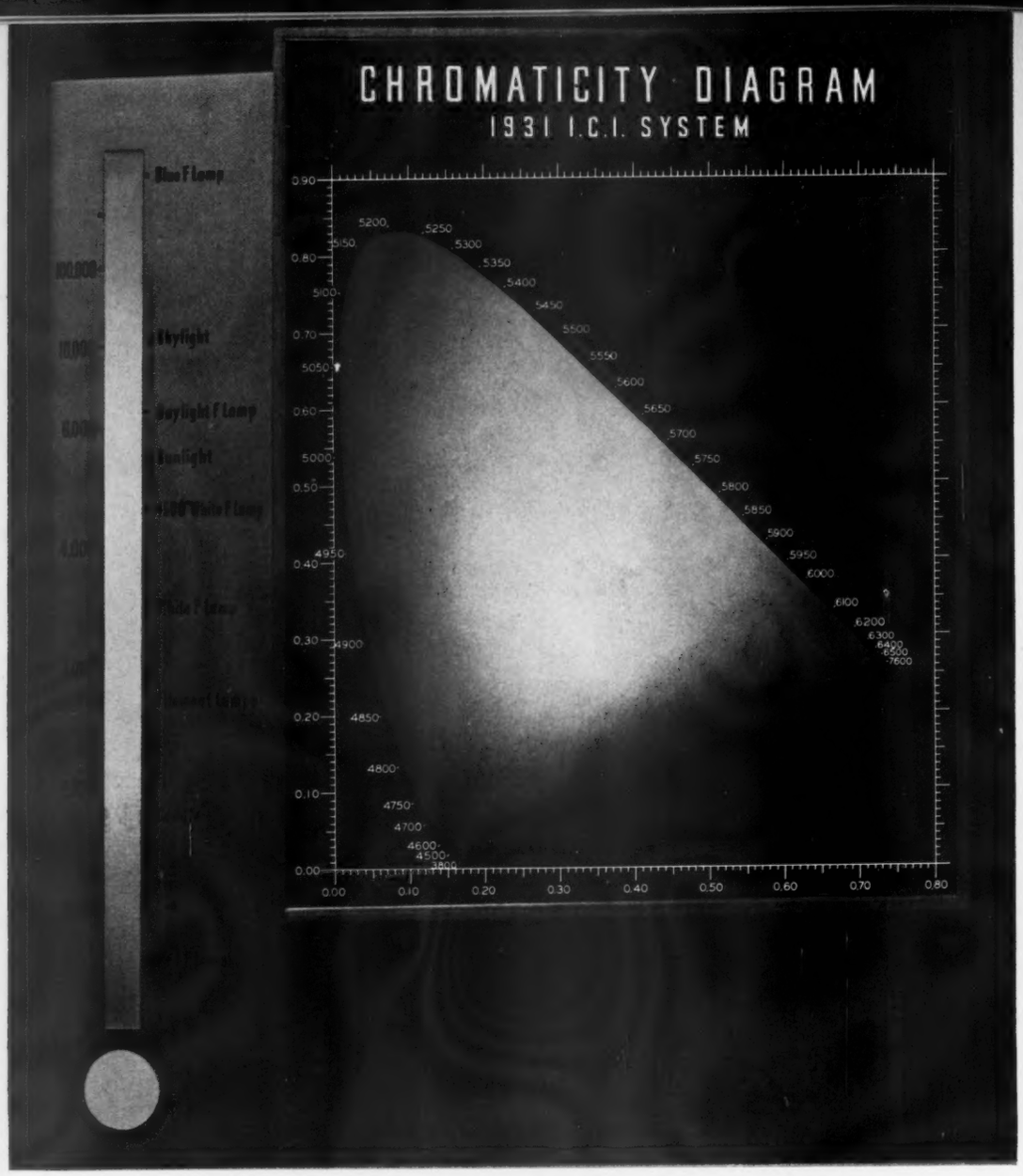


COLOR SELECTIONS FOR DAYLIGHTING

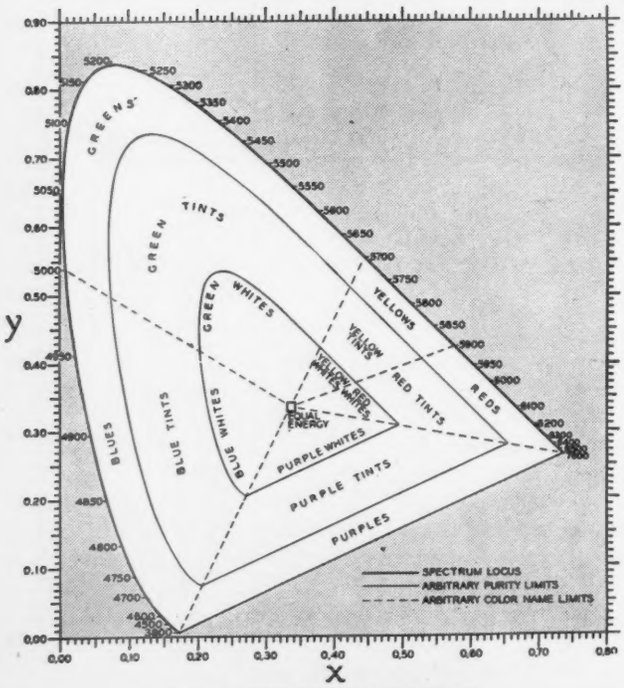
COLOR is an important subject for the illuminating engineer. Radiant energy which constitutes the visible spectrum is composed of pure spectral colors, or so-called color regions. In their simplest form, these color regions are divided into nine parts: violet, blue, blue-green, green, yellow-green, yellow, orange, light red and dark red. The visible spectrum is reproduced in color at the top of this page.

Light is produced by the radiant energy of wavelengths ranging from 380 to 760 millimicrons. Eyes perceive color sensation depending on how the radiant energy is distributed over these various wavelengths. Normal eyes are more sensitive to colors of relative equal energy in the green to yellow region of the visible spectrum, with the result that the eye-sensitivity curve peaks at this point from zero relative energy value at each end of the spectrum.

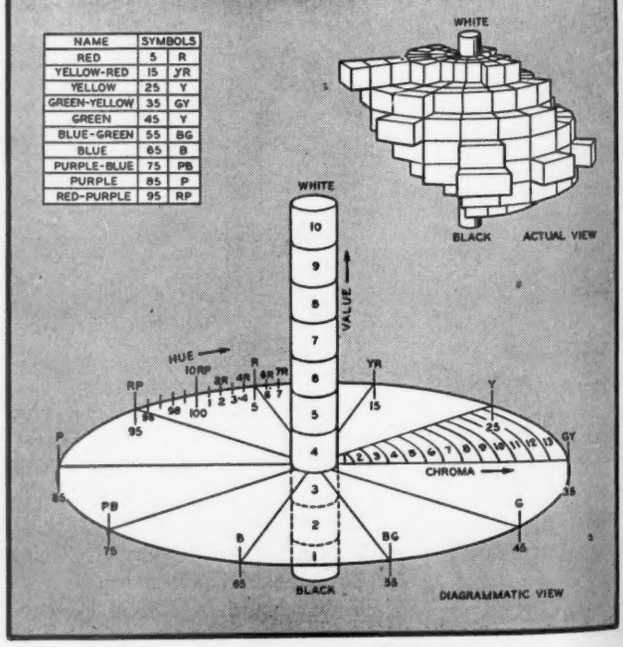
Various types of artificial light sources produce different color qualities of light. Even the color quality of daylight varies throughout the day and by geographical direction. Spectral distribution curves, which indicate the color, or "color quality", of an illuminant, thus become useful to the lighting engineer, since they indicate the amount of energy radiated at different wavelengths, or in different color regions of the spectrum. The white line superimposed on the full color spectrum (illustrated) is the spectral distribution curve for a 500-watt incandescent filament lamp. It will be noted that its radiant energy is greatest in the orange-red end of the spectrum, but that some energy is



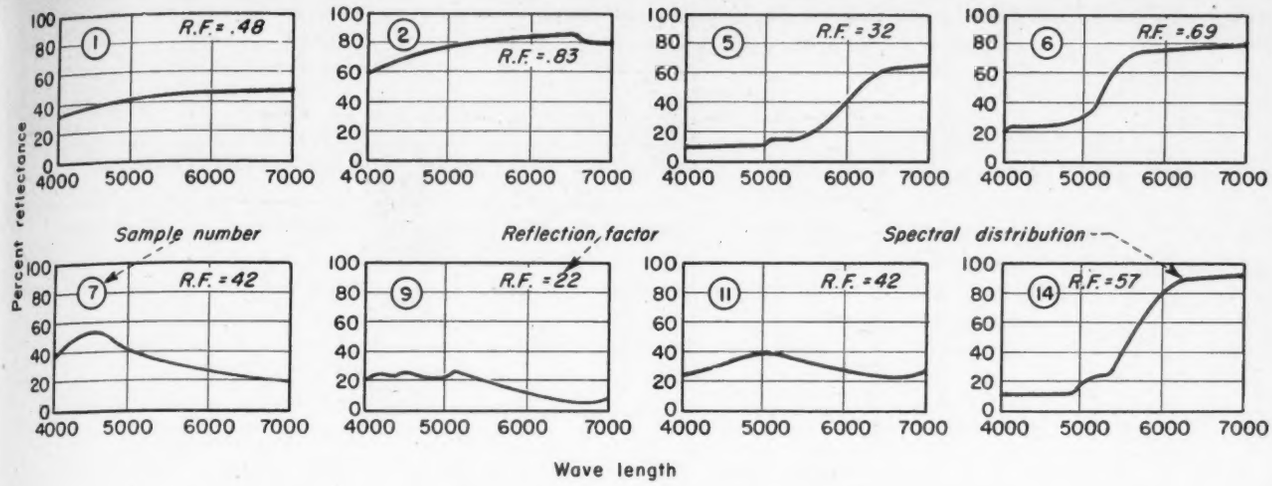
COLOR TEMPERATURE THERMOMETER AND I.C.I. CHART



I.C.I. COLOR DIAGRAM



MUNSELL COLOR SOLID



SPECTRAL DISTRIBUTION CURVES

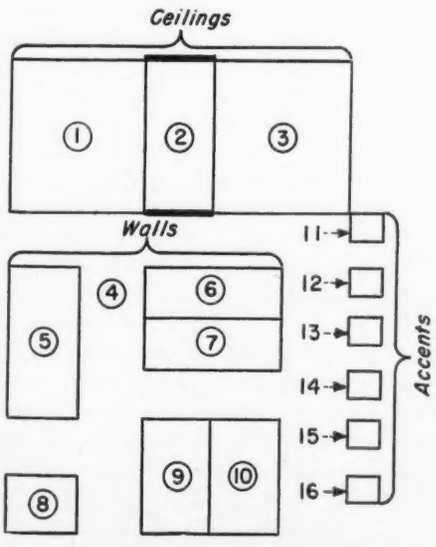
produced over the entire spectrum. This predominance of energy in the red end of the spectrum accounts for the "yellowish-orange" appearance of filament lamps, as compared with white light or daylight. The eye is not capable of distinguishing the many colors inherent in a light source, but groups the many hues into an apparent single color value which is represented by the spectral hue or color that it most closely matches.

Spectral distribution curves can also be made for colored surfaces such as fabrics, paint, wood, metal or plastic. In the full-color spectrum chart (illustrated) there is also shown a spectral distribution curve for a sample of blue paint (Arco Optomic Color No. 2 blue). This spectral distribution is represented by the black curve. As would be supposed, it peaks in the blue region. Comparing it with the spectral distribution curve for the 500-watt incandescent lamp, it is seen that the paint color complements the color quality of the light source. The paint thus helps to improve the color balance in lighting.

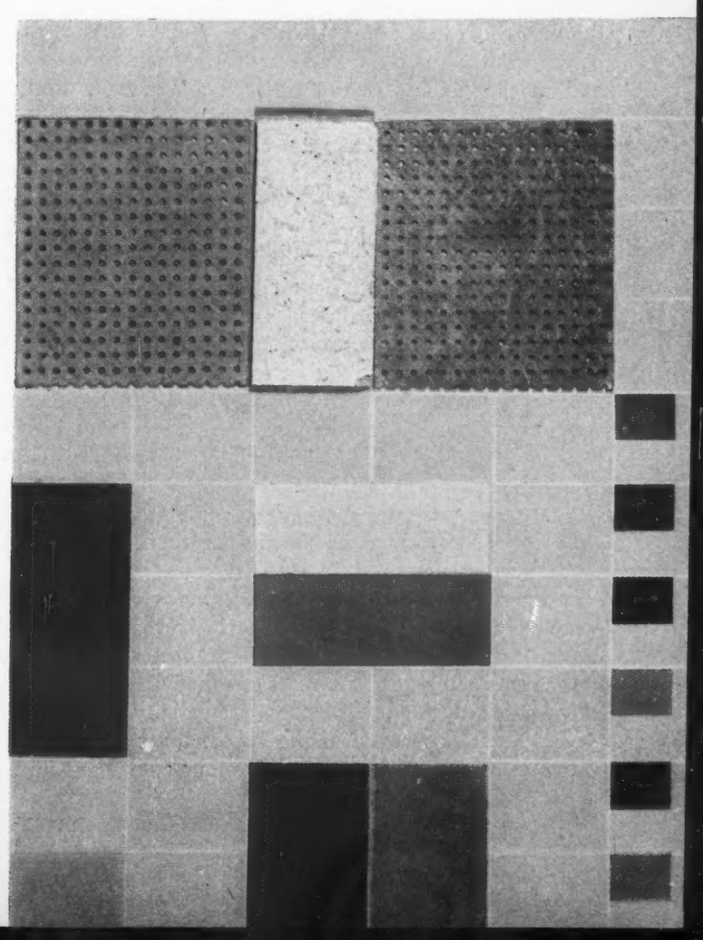
The chart, "Color Selections for Daylighting", shows paint color selections which improve color balance for daylighting in rooms with respect to their geographical location. For example, the warmth of "tan" complements the coldness of rooms located so as to receive daylight from the north sky, or "blue" complements the warmth of light from the sun or southern sky in a room having southern exposure. Paint colors which complement natural light in rooms with other exposures are also shown.

Reproduced in color at the bottom of this page are true color samples of several of the colors and finishes used throughout the new General Electric Lighting Institute, Nela Park, Cleveland. Spectral distribution curves for eight typical color samples are reproduced above. Reflection factor for each color sample, measured when lighted with 4500-degree fluorescent white, is also shown. The reflection factor is a measure of luminosity, and not an energy function. Luminous reflectance is usually the first color attribute to be selected for any type of interior, since both the efficiency of the lighting system and brightness-contrasts are affected by the luminous reflectance of surfaces throughout the area to be lighted.

As can be seen from the above discussion, colored light and colored surfaces are both inherent factors to some degree on every lighting installation, whether for utility or



KEY TO COLOR CHART



EFFECT OF VARIOUS ILLUMINANTS ON INTERIOR PAINT COLORS

Paint Color	Munsell Color Designation	Approx. Reflect. Factor*	Filament	Soft White Fluorescent	White Fluorescent	4500 White Fluorescent	Daylight Fluorescent
Cherry Red	5.0 R 4/14	.13	Brilliant Orange Red	Pinkish Red	Pale Orange Red	Yellowish Red	Light Red
Orchid	10.0 RP 7/8	.44	Light Pink	Dusky Pink	Gray Pink	Light Pink	Good Match (grayer)
Plum	10.0 RP 2/2	.04	Deep Orange Red	Reddish Purple	Dark Brown	Light Reddish Brown	Deep Bluish Purple
Chestnut Brown	7.5 YR 5/2	.19	Medium Yellow Brown	Pinkish Brown	Gray Brown	Light Brownish Gray	Light Gray
Peach	2.5 YR 8/4	.58	Pinkish Yellow	Light Pink	Light Yellowish Pink	Very Light Pink	Fair Match (lighter)
Orange	5.0 YR 7/8	.44	Bright Orange	Light Pink	Pale Yellow	Light Yellow	Gray Yellow
Canary Yellow	10.0 YR 7/8	.44	Orange Yellow	Light Orange Yellow	Greenish Yellow	Light Yellow	Fair Match
Light Yellow	2.5 Y 8/8	.58	Vivid Orange Yellow	Pinkish Yellow	Medium Yellow	Light Bright Yellow	Light Greenish Yellow
Sea Foam Green	7.5 GY 8/4	.58	Greenish Yellow	Very Light Gray	Weak Gray Green	Light Yellowish Green	Good Match
Jade Green	2.5 G 5/4	.21	Vivid Yellow Green	Pale Gray Green	Weak Yellowish Green	Yellow Green	Fair Match (lighter)
Light Blue	5.0 BG 7/4	.46	Light Yellowish Green	Light Bluish Gray	Weak Greenish Blue	Blue Gray	Fair Match (lighter)
Medium Blue	5.0 PB 5/10	.23	Blue Green	Weak Gray Blue	Purplish Blue	Light Gray Blue	Fair Match (lighter)
Silver Gray	2.5 Y 8/2	.57	Light Yellow Gray	Pinkish Gray	Light Brownish Gray	Very Light Gray	Bluish Gray

Samples under the five illuminants were compared with identical samples under a Macbeth Daylighting Unit (color temperature 7000°K). "Good Match" indicates that the color of the sample so designated most nearly matched the standard under the Macbeth unit. The footcandle intensity of all illuminants was approximately the same. The Munsell designations are approximate, and were determined under the Macbeth unit.

*For Standard ICI Illuminant C, representative of average daylight.

Source: Westinghouse Lighting Handbook.

decorative effect. Careful consideration should therefore be given to both the aesthetic and the functional phases of color as it relates to lighting. It may not always be possible at this stage of development in the science of color work to obtain spectral distribution curves for various paints, fabrics and interior finishes, or to have such curves made promptly. These curves are, however, generally available for light sources in data bulletins published by lamp manufacturers, in the new IES Lighting Handbook, and various other publications.*

Creating color harmony in design is a job for the artist. It is the job of the physicist and the engineer, however, to provide the technical basis for translating the conceptions of the artist into actualities. Thus, the lighting engineer, either consciously or unconsciously, becomes an application engineer in problems relating to color.

The chromaticity of a color is specified by dominant wavelength, purity and luminous reflectance (I.C.I. system for specifying color). A full color chromaticity diagram is illustrated herein. Each color seen by the normal human eye is represented by some point within this diagram, and it is stated by some authorities that there are perhaps 10,000,000 recognizable colors. (*Dictionary of Color,* by A. Maerz and M. Rea Paul contains over 7000 samples with color names based on historical origins and current usage). A color temperature "thermometer" (chromaticity of a completely radiating "black body" source) is also illustrated at the left of the chromaticity diagram. The outer horseshoe curve of the chromaticity diagram represents pure spectrum colors. All other colors are mixtures of various wavelengths of light and lie within the area of the pure color chromaticity curve. When all wavelengths of light are mixed in equal proportion, perfect white light results and is represented by a point in the exact center of the diagram. Intermediate points represent mixtures of white plus a given wavelength. Thus, a chromaticity diagram can be used as a "Fluorescent Lamp Color Mixing Nomogram", illustrated previously. It also permits the correlation of color temperature with color nomenclature, wavelength and saturation, as illustrated in the "I.C.I. Color Diagram" (illustrated). In this diagram the dotted curve represents the color temperature "thermometer".

A typical color problem faced by the lighting engineer on practically every planned lighting layout is that of selecting the correct illuminant, so that colors of ceilings, side walls, floor coverings, decorative fabrics and interior furnishings will appear in their "natural" colors. The "natural" color is commonly accepted as that of its appearance under average daylight. The Table above shows the effect which various commonly used illuminants have on some of the more popular types of paint colors. These colors have been related to the Munsell system of color designation, as shown in the second column.

All color surfaces, whether paint, food, vegetables or other, should be considered when selecting an artificial illuminant.

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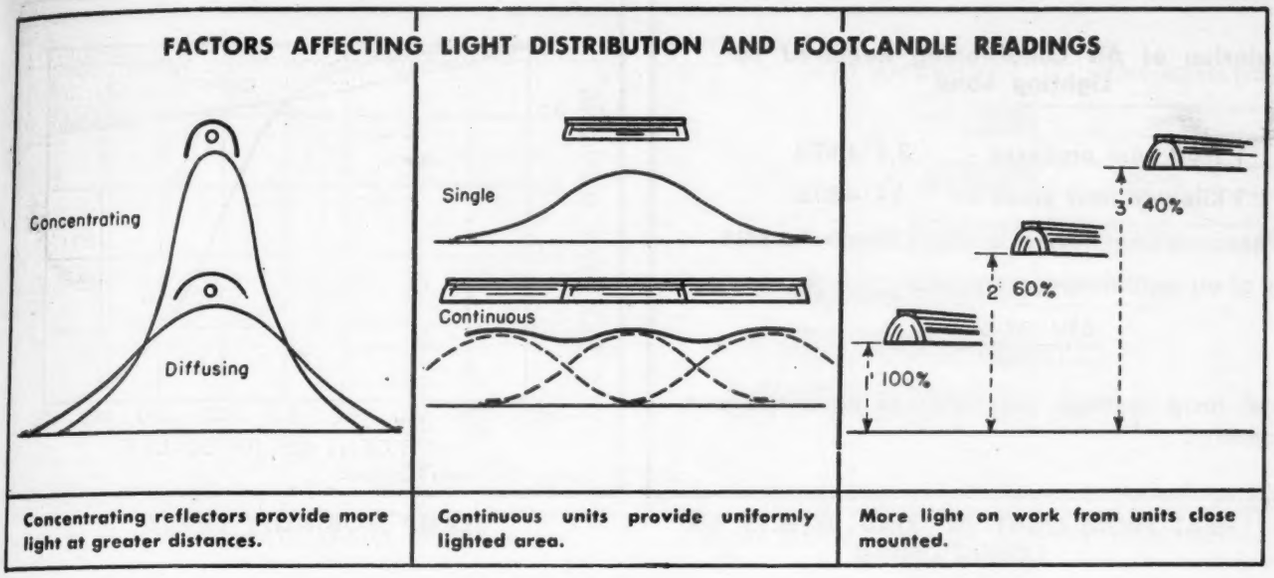
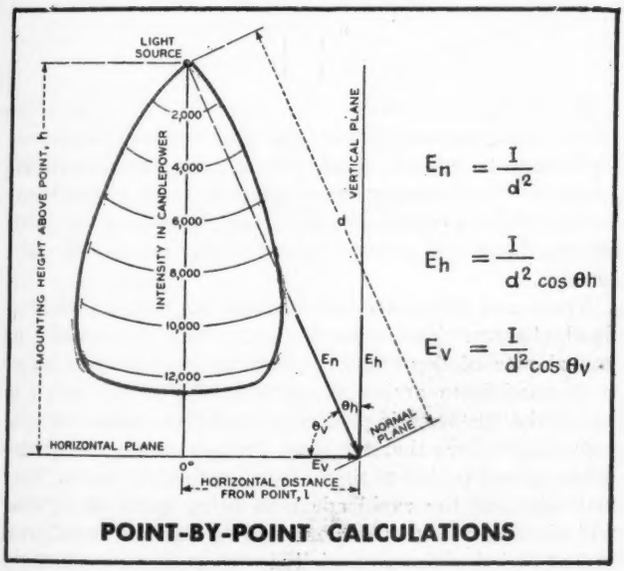
* *(Fluorescent Lighting Manual, Second Edition, by C. L. Amick, Chapter VIII. Published by the McGraw-Hill Book Company.)*



SUPPLEMENTARY LIGHTING



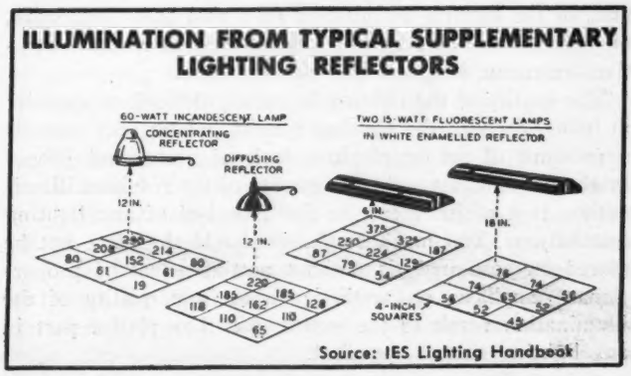
PLANNED LIGHTING

SUPPLEMENTARY lighting is used when seeing tasks require illumination levels in excess of values which are economical for general lighting. Current practice is to provide up to 100 footcandles of general lighting throughout an area, and to provide higher intensities, ranging up to 500 footcandles, over small work areas with supplementary type reflectors installed close to the areas. In those areas where lighting levels are below 50 footcandles, supplementary units are also used to provide intensities in excess of this value.

Concentrating reflectors attached to adjustable brackets and mounted on machines or benches are desirable for providing intensities of 200 to 300 footcandles. Such intensities should be provided only for objects having low reflection, and where general lighting levels are on the order of 50 footcandles or above, since local spots of high intensity in relatively dark areas can and usually do result in glare. Continuous row diffuse reflector type fluorescent units are ideal for bench lighting or for fine parts assembly lines. These units may be mounted directly over the work area, but care should be used to shield the light sources from the workers' eyes.

The point-by-point method of calculation is useful in determining estimated intensities from individual supplementary type reflector units. It is necessary, of course, to have a candlepower distribution curve of the reflector being considered. The intensity may then be calculated for a point at any angle from the center axis, or on the axis, using the formulas shown in the illustration at the left.

Supplementary lighting units have many applications, in industry, stores, public buildings, the office and in the home. Many types of units are available, both for incandescent and fluorescent lamps. Four typical types, and footcandle values for a small area at specified distances which result from each type are shown in the illustration below.



Calculation of Air Conditioning Required for Lighting Load

1 Watt hour produces 3.414 BTU

1 Kilowatt hour produces 3414 BTU

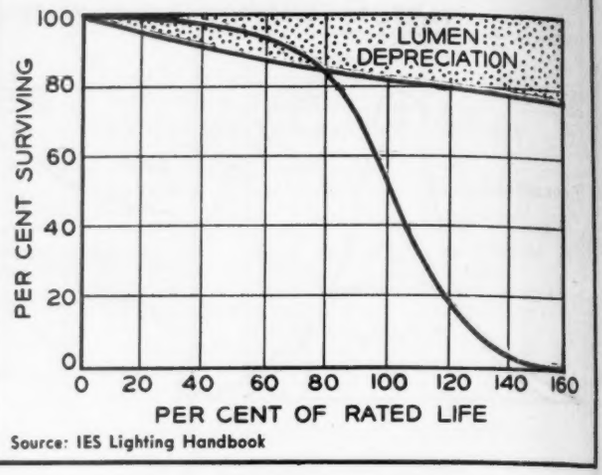
BTU generated per hour = Lighting kilowatts* x 3414

Tons of air conditioning required =

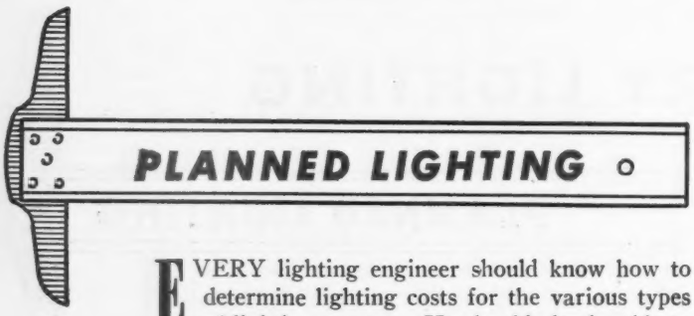
$$\frac{\text{BTU per hour}}{12000}$$

***Total lamp wattage plus wattage of auxiliary equipment.**

HEAT FROM LIGHTING LOAD AFFECTS AIR CONDITIONING



LAMP MORTALITY CURVE



LIGHTING

EVERY lighting engineer should know how to determine lighting costs for the various types of lighting systems. He should also be able to make cost comparisons between the various ways of solving a specific lighting problem.

Most lighting customers use cost as a basis for appraisal when they discuss a new lighting installation. They want to know what the initial or first cost of the installation will be, and how much it will cost them to operate it. If the customer is considering more than one type of installation he is interested in comparative costs between the various types under consideration. It is only natural, therefore, that the lighting engineer best qualified to make an intelligent appraisal of all factors involved in the economics of the lighting installation will be the one to sell the best quality job from a lighting appraisal viewpoint.

The economics of lighting embrace various factors, some of which cannot be appraised on a dollars-and-cents basis. Appearance and quality of the lighting result fall into this classification. Certainly it would be very difficult to put a cost value on the appearance of the lighting in a highly decorated night club, restaurant or cinema auditorium, in which light is used as the decorative medium or to form a part of it. Likewise, it is difficult to appraise the appearance of the lighting installation on a cost basis in a store, office, classroom or even in an industrial area where decorative treatment is given less consideration.

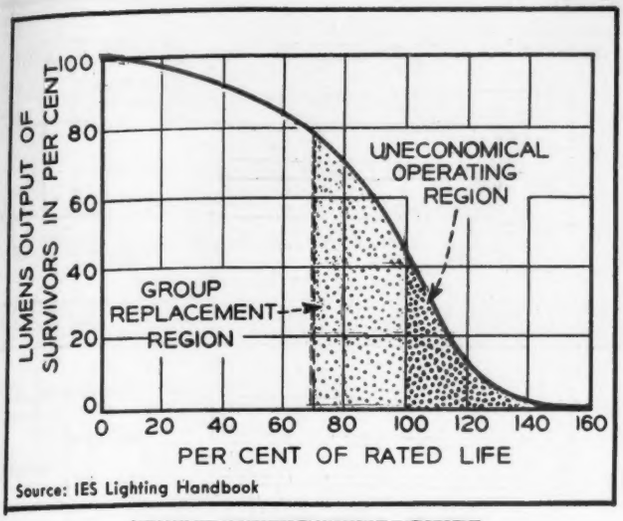
The quality of the lighting is equally difficult to appraise in items of cost. Yet lighting quality, which in a sense is a measure of seeing comfort, lack of glare, and proper brightness-contrast and color quality of the resultant illumination, is a major factor in the appraisal of any lighting installation. Too much emphasis should therefore not be placed on cost analysis without putting equal or proportionate emphasis on aesthetic values and quality of the illumination result to the extent that they play a part in any lighting system appraisal.

In making a cost analysis for any specific lighting installation, it is common practice to divide costs into two groups, one group to include *fixed charges*, the other, *operating charges*. Fixed charges cover the initial cost of the installation, while operating charges cover the cost of electrical energy, lamp and defective parts replacements and maintenance.

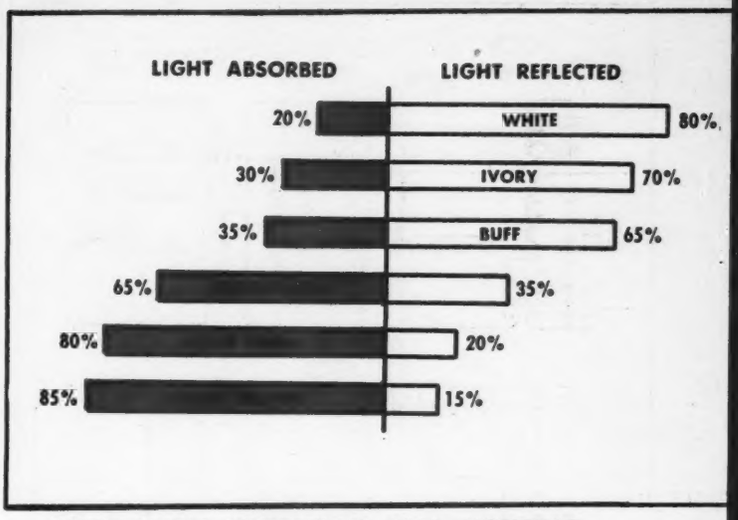
There are differences of opinion on how to amortize fixed charges. This amortization, which is normally an annual rate of depreciation, must be decided upon before it is possible to arrive at an "annual cost of light", in which the customer is primarily interested. Some lighting engineers believe that the fixed charges should be written off in a short period of time, from five to eight years. They maintain that the rapid advances being made in lighting will obsolete today's most outstanding lighting installation in that period of time, especially in stores, restaurants, night clubs, theatres, hotel lobbies and ballrooms, and similar areas which depend upon frequent modernization and redecorating to attract and hold the public's interest.

Other lighting engineers believe that a well planned modern lighting installation should be amortized over a longer period of time. They use from ten to 15 years as a basis for depreciating the fixed charges. They maintain that the majority of recently relighted offices, schools and factories were previously lighted with the same old system for from twelve to 20 years.

Perhaps the wisest procedure is to discuss the rate of amortization with the customer, and to base depreciation allowances on the customer's own method of accounting procedure. When this is not feasible, the following basis is recommended for determining "yearly owning cost," including depreciation, interest on the declining principal, taxes, insurance and repairs. For installations which are subject to frequent changes in decorating, such as stores, restaurants, night clubs, etc., use 20 percent of the initial first cost as the yearly owning cost. This will roughly average



LAMP REPLACEMENT GUIDE



HIGH LIGHT REFLECTION AIDS LIGHTING EFFICIENCY

ECONOMICS

an eight-year write-off for the entire installation. For offices, schools, factories and similar installations not subject to frequent redecorations or modernizations, use 15 percent of the initial first cost as the yearly owning cost. This figure will roughly represent a twelve to 13 year write-off for the entire installation.

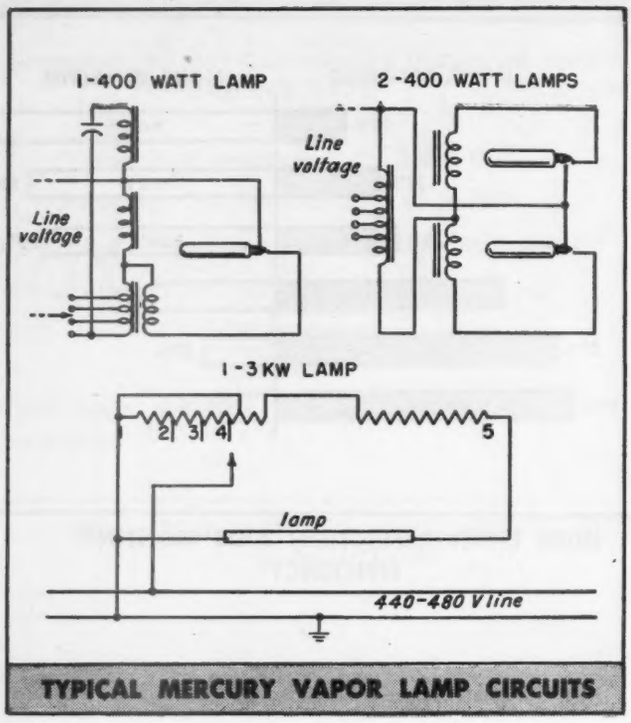
In estimating the initial cost of a lighting installation, it is sometimes difficult to decide just what should be included as making up the installation. The contractor sometimes lists "lighting equipment" as one item, "wiring" as another, and "installation" as still another, in working up his bid, or in submitting his bill, especially when working on a time-and-material basis. The cost of the "lighting equipment" in this case should not be considered as the total initial cost of the lighting installation when attempting to make an accurate cost comparison between installations.

For purposes of cost comparisons, there are many factors to be considered. The reasons will be apparent from the following discussion. It is considered that the following factors are all pertinent, depending on the type of lighting system used, and whether or not these factors are involved on the project. Items which should be included as part of the lighting installation are listed below.

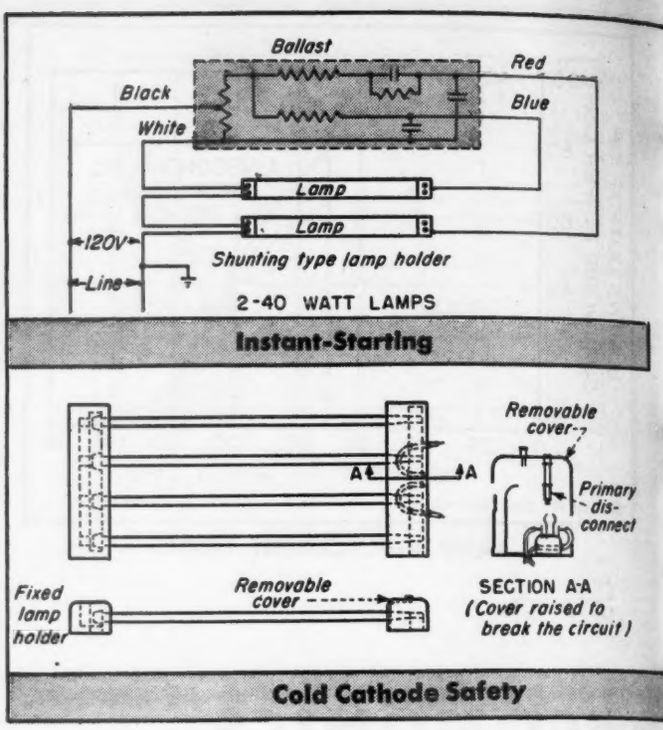
1. *Total cost of all luminaires or lighting equipment.* In the case of cove lighting or other special applications, the cost of wiring channel, reflectors, color lenses, or other special equipment of this type should be included.
2. *Total cost of all wiring.* This should include all wiring materials, such as conduit, wire, switches, boxes, panels, feeders and transformers, including labor for installing. Where transformers or distribution systems are also used for power loads, the cost of these items should be proportioned between power and lighting.
3. *Proportionate cost of air conditioning required to dissipate lighting load.* Obviously, this will apply only when air conditioning is used. It will affect lighting installation costs for comparison purposes only when there is a substantial difference in lighting load, such as incandescent lamps versus fluorescent lamps.
4. *Construction cost differences due to the lighting installation.* The installation of coves, coffers, soffits, troffers, louvered ceilings, luminous ceilings and other forms of recessed or built-in types of equipment may involve structural changes or special construction. These costs cannot logically be classified as lighting installation costs, but the differences in construction costs should be applied to the lighting installation costs for purposes of comparison of one lighting system with another.

Operating charges include the net cost of lamps and starter switches used for replacement, the cost of electrical energy, including demand charges where they exist, and cleaning and maintenance costs. Large users of lamps usually purchase lamps at a discount on a contract basis, and net costs should be used. Electrical energy rates and demand charges can be obtained from the local electrical utility company. It is also a simple matter to work up a table of "annual operating costs" for a specific lighting load based on different rates of cost per kilowatt-hour for the electrical energy. Cleaning costs based on different cleaning frequencies per year may also be combined in the same table. Repairs and replacements of ballasts, starter switches, lampholders, glassware, plastic diffusers, etc., are considered maintenance items, and therefore part of the annual operating cost.

The cost of lamps represents a very small part of the cost of producing light, usually less than ten percent. It is therefore economical to replace lamps when they have reached the end of their rated life, since energy will be used which does not produce any light due to lamp lumen depreciation. The finishes of ceilings, walls, floors, furniture and machinery also affect lighting efficiency, as shown by the coefficient of utilization tables. Proper reflectance of paints and finishes and their maintenance can be justified easily by cost analysis, comparison of the area being considered when lighted to the desired intensity, but painted in finishes of varying light reflection values.



TYPICAL MERCURY VAPOR LAMP CIRCUITS



LIGHTING COMPONENTS

PLANNED LIGHTING

INCANDESCENT or filament lamps are easily adapted for use in luminaires or reflector equipment. All that is required is a lampholder, or socket, and wire. Sockets are usually simple in design, and for standard type lamps used for general lighting, are either medium screw base, mogul screw base or mogul bi-post base. Adequate mechanical strength, proper electrical characteristics, and ability to withstand the amount of heat generated by the lamps constitute the main requirements for these accessories.

Fluorescent and mercury vapor lamps are forms of "electric discharge" light sources. Thus, they require auxiliary equipment for their operation, commonly referred to as "ballasts" for low voltage (preheat cathode) lamps, or "transformers" for high voltage (cold cathode) lamps. Variations in diameter and length of lamps, and in type of electrodes used, make it necessary to provide many sizes and types of ballasts, or transformers, each size and type being specifically designed to meet the specific requirements for each size, number and type of lamp. This accounts for the large number of types of ballasts or transformers which are available.

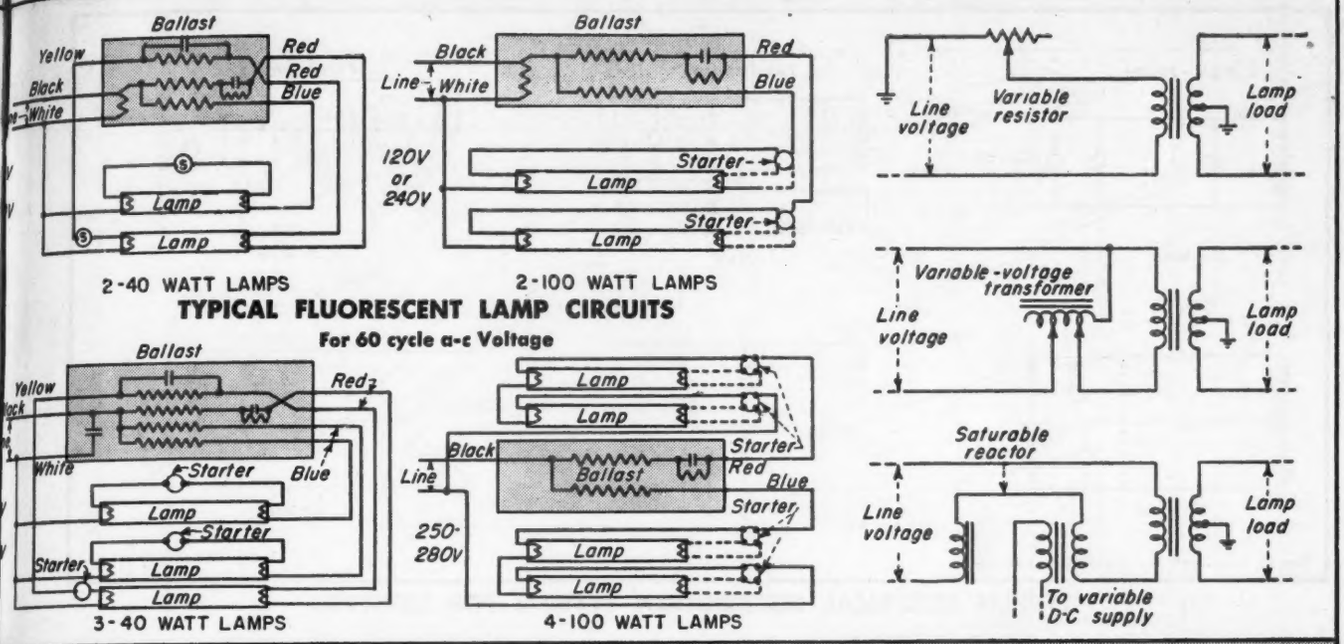
In the Table on next page are listed those ballasts most commonly used with standard preheat-cathode fluorescent lamps. Other types are also available from the various transformer manufacturers, for use with single lamps, also for use with slimline, circular and cold cathode type lamps. Ballasts consume electrical energy, which load must be taken into account when estimating the efficiency of a lighting system, and when making the wiring layout. These losses vary considerably with relation to the lamp wattages controlled, as may be readily seen in the Table. It is therefore important to consider the type of ballasts which will provide the maximum efficiency in combination with the size of lamps proposed for each lighting application.

High power factor ballasts offer four distinct advantages over low power factor types, and should be used on all general lighting applications. These advantages are: 1) line current is kept normal and less circuit capacity is required; 2) additional lamps may be installed on many existing circuits; 3) voltage conditions are improved; and 4) the load on generating equipment is reduced.

Starter switches are required for preheat-cathode fluorescent lamps. These switches are used to first preheat the cathodes and then to quickly open the circuit to permit the inductive kick to start the lamp. Shown opposite are four automatic types of starter switches. These are of the replaceable type. They are made in several sizes and types to meet the different characteristics of the various lamp sizes with which they are designed to be used.

Lampholders for fluorescent lamps are made in a variety of types and for different methods of mounting. They are classified as miniature bi-pin for small wattage lamps, medium bi-pin for 15- to 40-watt lamps, and mogul bi-pin for 100-watt lamps. In addition there are slimline lampholders, circular lamp lampholders and cold cathode lampholders. Typical types are shown on the next page.

Wiring diagrams for some of the more popular types of ballasts and transformers for use with standard fluorescent and mercury vapor lamps are shown above.



TYPICAL FLUORESCENT LAMP CIRCUITS

For 60 cycle a-c Voltage

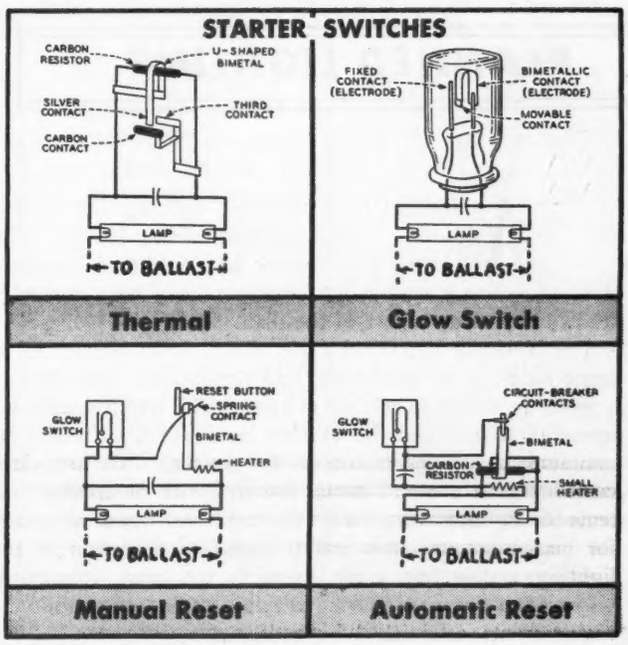
Preheat-Starting | **Cold Cathode Dimming**

LAMP WATTS	WEIGHT, POUNDS	LINE CURRENT	WATTS LOSS
For 60 cycle, 110-125 Volt Circuits			
2-15	3¼	0.35	9.0
2-20	3¼	0.45	9.0
2-30	7	0.70	12.5
2-40	7	0.85	15.5
3-40	11	1.30	23.0
2-100	14½	2.10	32.0
For 60 cycle, 199-216 Volt Circuits			
2-30	7	0.40	10.0
2-40	7	0.50	11.5
3-40	9¾	0.70	16.0
2-100	14½	1.25	32.0
For 60 cycle, 220-250 Volt Circuits			
2-30	7	0.35	10.5
2-40	7	0.43	12.5
3-40	9¾	0.60	20.0
2-100	14½	1.10	32.0
For 60 cycle, 240-280 Volt Circuits (For Y-connected networks, line to neutral)			
2-40	7	0.40	15.0
3-40	10¼	0.60	20.0
2-100	15	1.00	35.0
4-100	17½	1.65	36.0

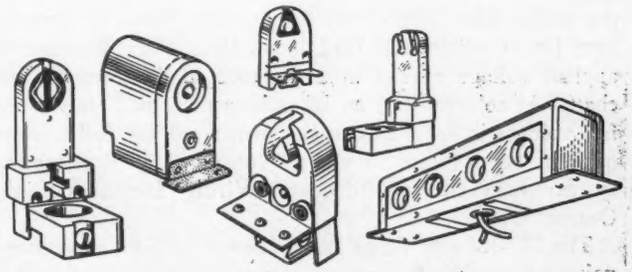
* Reference data given is for standard high power factor ballasts of standard cross-section type, designed for use with the number of lamps of wattages as listed. For dimensions and other data on these ballasts, and for information on other type ballasts, manufacturers' catalogs should be consulted.

Source: General Electric Company Bulletin LD-1.

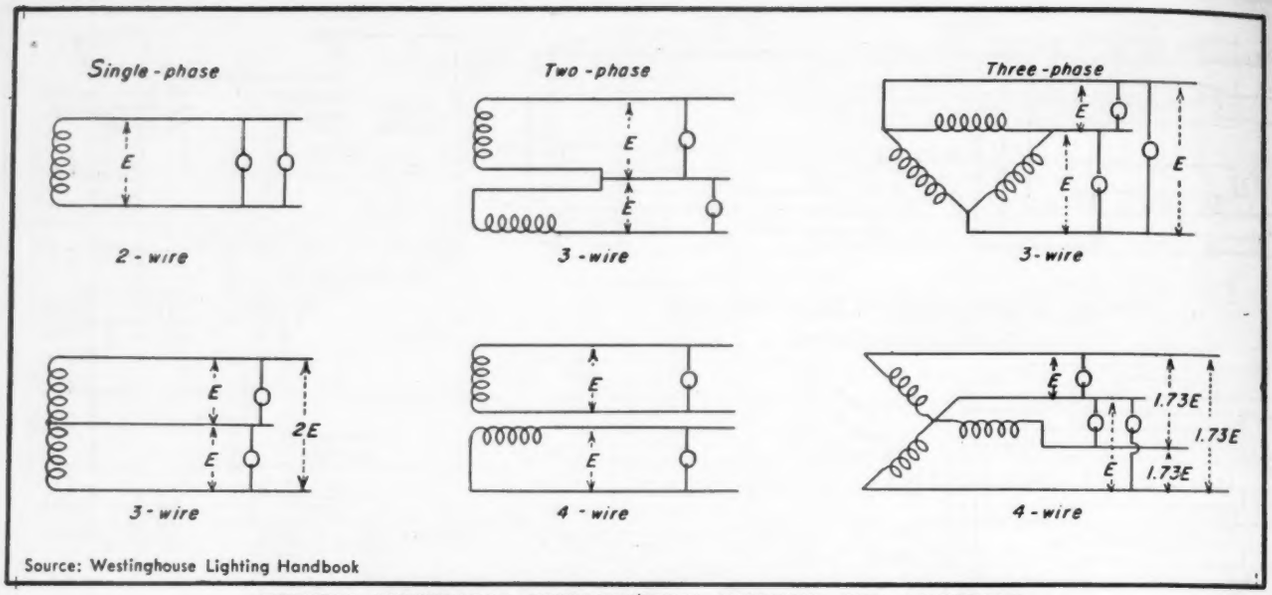
TYPICAL FLUORESCENT LAMP BALLASTS*
For General Lighting



Source: IES Lighting Handbook



TYPICAL FLUORESCENT LAMPHOLDERS



Source: Westinghouse Lighting Handbook

TYPICAL ELECTRICAL DISTRIBUTION SYSTEMS FOR LIGHTING

WIRING FOR LIGHTING

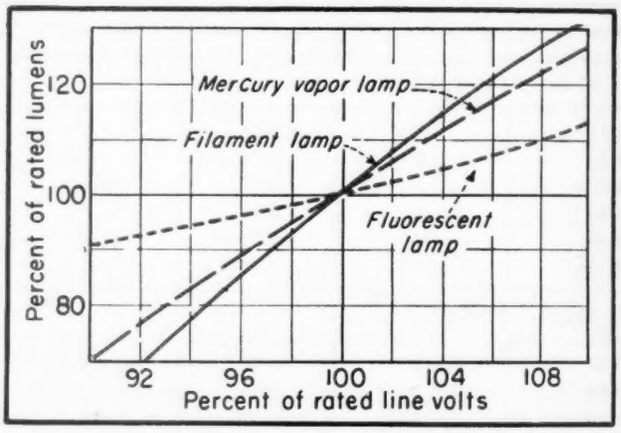
PLANNED LIGHTING

A CAREFULLY planned lighting installation deserves a well planned wiring system. The lighting plan cannot be considered complete until the wiring system and controls have been carefully studied and made a part of the plan.

The National Electrical Code, which is supplemented in many localities by local codes and regulations, is written as a guide to safety in wiring systems. The requirements set up by this Code and the various local codes are based on minimum requirements for safety. In an effort to reduce costs to a bare bones basis, the majority of wiring systems for lighting fail to meet the requirements of adequacy for maximum efficiency and trouble-free operation of the lighting system. In most instances the most economical wiring job for the owner will far exceed the minimum requirements established by codes.

The wiring system should be designed so that full rated voltage exists at the socket for incandescent lamps, or at the ballast lead connections for mercury vapor or fluorescent lamps, when full load is applied. Any decrease in applied voltage results in a decrease in light output and change in color quality on incandescent lamps. Only when full voltage is supplied can the owner get the full amount of light he pays for in energy consumed by the lighting system (see chart, "Adequate Wiring Increases Light Output").

The 110-125 volt range is not always the most economical voltage range for fluorescent or mercury vapor lamps. For example, the lumens per watt for 40-watt fluorescent lamps operated on a 3-lamp ballast designed for 110-125 volt range is 48.2 lumens per watt, taking into account the watts lost in the ballast. When 40-watt fluorescent lamps are



ADEQUATE WIRING INCREASES LIGHT OUTPUT

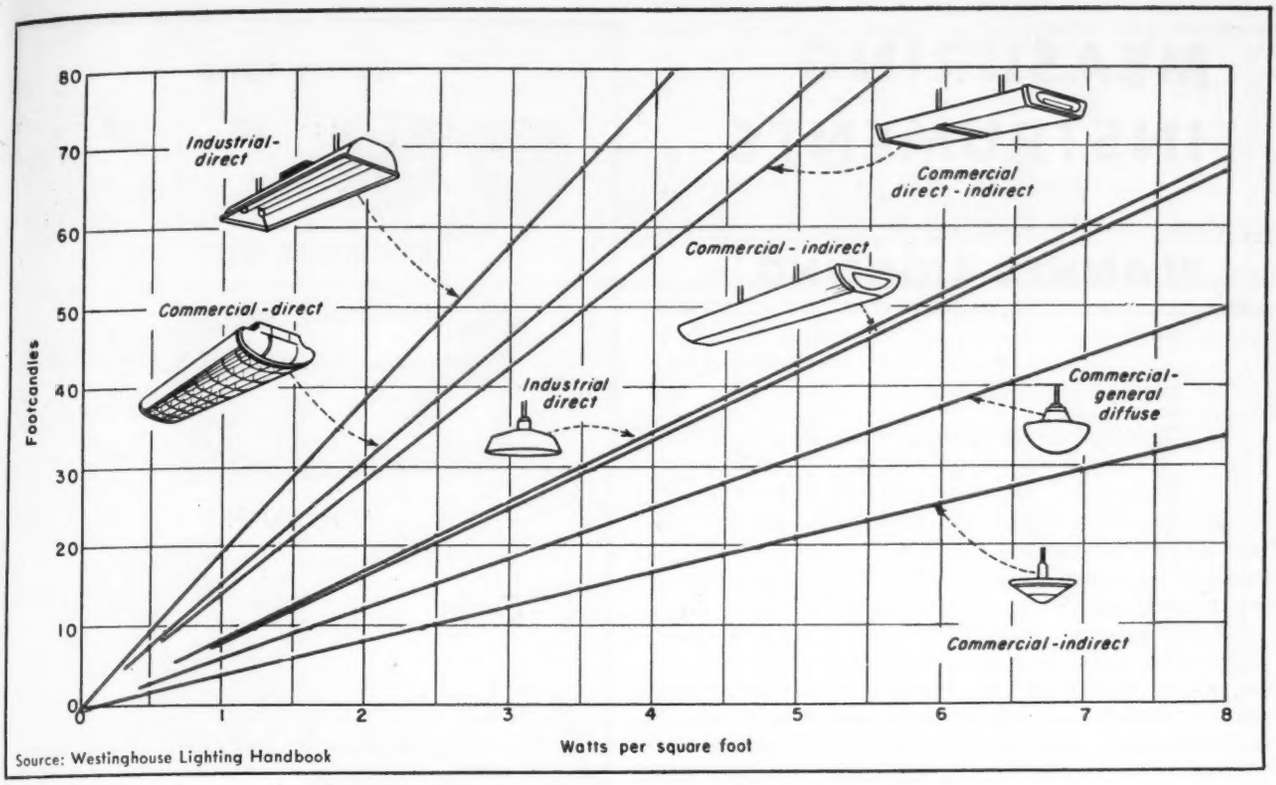
Source: Westinghouse Lighting Handbook

MORE LIGHT WITH HIGH POWER FACTOR BALLASTS

Capacity of 15-ampere 115-volt branch circuit

Size lamp (Watts)		15	20	30	40	100
FLUORESCENT						
Watts loss per ballast*		4.5	4.5	9.0	9.5	24.0
Total permissible watts	90%	1550	1550	1550	1550	1550
Number of lamps	P. F.	79	63	39	31	12
Permissible lamp watts		1185	1260	1170	1240	1200
Watts loss per ballast*		4.5	4.5	9.0	9.5	24.0
Total permissible watts	55%	950	950	950	950	950
Number of lamps	P. F.	48	38	24	19	7
Permissible lamp watts		720	760	720	760	700
INCANDESCENT						
Permissible lamp watts	Unity P. F.	1725	1725	1725	1725	1725

*Approximate watts loss for single lamp ballasts rated 110-125 volts, 60 cycles.



Source: Westinghouse Lighting Handbook

WIRING CAPACITY LIMITS LIGHTING INTENSITIES

FLUORESCENT LAMP LUMENS PER WATT
After Adding Ballast Watts Loss

Type of Ballast	Approx. Watts Loss	Total Lumens	Lumens* per Watt
	110-125 VOLT RANGE		
1-40	9.5	2300	46.5
2-40	15.5	4600	48.2
3-40	23.0	6900	48.2
1-100	24.0	4200	33.9
2-100	32.0	8400	36.2
	199-216 VOLT RANGE		
1-40	8.5	2300	47.5
2-40	11.5	4600	50.3
3-40	16.0	6900	50.7
1-100	30.0	4200	32.3
2-100	32.0	8400	36.2
	220-250 VOLT RANGE		
1-40	9.5	2300	46.5
2-40	12.5	4600	49.8
3-40	20.0	6900	49.3
1-100	30.0	4200	32.3
2-100	32.0	8400	36.2
	240-280 VOLT RANGE		
2-40	15.0	4600	48.5
3-40	20.0	6900	49.3
2-100	35.0	8400	35.7
	250-280 VOLT RANGE**		
4-100	36.0	16800	38.5

Approximate watts loss is based on high power factor 60 cycle ballasts.
*Total lumens are based on 3500-degree white fluorescent lamps. Lumens per watt is the ratio of total lamp lumens generated to lamp wattages plus watts loss in ballasts.
**For use on Y-connected network distribution system rated at 254/440, 265/460 or 277/480 volts. Source: Based on data from General Electric Co. Bulletin LD-1, May 1946.

operated on a 3-lamp ballast designed for the 199-216 volt range, the efficiency is increased to 50.7 lumens per watt. The higher voltage range also reduces the line current from 1.30 amperes for the 110-125 volt range to .70 amperes for the 199-216 voltage range. When the same size conductors are used, there will be less voltage drop on the higher voltage range, and greater efficiency in light output.

On new wiring installations, a careful analysis should be made to determine which type of electrical distribution system will most adequately meet the needs of the lighting load. Six typical electrical distribution systems for lighting are shown at top of the page opposite. The single-phase two- and three-wire systems are normally used for small lighting loads, while the three-phase four-wire system is commonly used for large lighting loads. Full analysis of the distribution problems for each lighting installation, particularly where fluorescent or mercury vapor lamps are used, may indicate economies for higher voltages, or a change in the type of distribution system.

The chart at the top of this page will be useful in determining lighting levels which may be expected from various types of luminaires on relighting installations where the wiring is already installed. A check of the wiring system will indicate the "watts per square foot" capacity available. Using this value in the chart, it is easy to determine the "footcandles" which a particular type of luminaire will produce, or to determine what type of luminaire will produce the desired level of illumination. This chart should be used as a rough guide only, after which a more accurate check should be made by computations as previously outlined.

The importance of using high power factor ballasts on either a new installation or a relighting job is shown in the Table at the bottom of opposite page. The "permissible lamp watts" on any circuit will be considerably less, when low power factor ballasts are used, thus decreasing the amount of light which may be produced.

MEASURING INSTRUMENTS

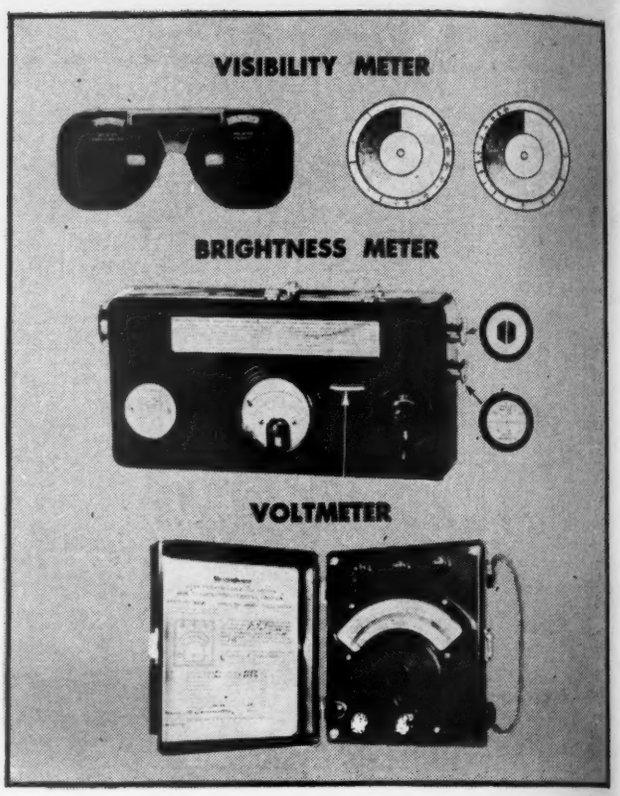
PLANNED LIGHTING

THE illuminating engineer today must have an appreciation of art, as well as of science. He must be able to recognize various periods of architecture and decoration. He must have a sense of color harmony, and understand psychological and physiological reactions to various color schemes. Such appreciation is usually developed through experience and observation.

On the scientific and technical side of lighting, much progress has been made in recent years. Continuous research and studies on the "Science of Seeing" by the research laboratories, and by many renowned researchers have developed scientific and technical data and adequate information to enable lighting engineers to predetermine lighting intensities and lighting results to a remarkable degree of exactness.

Good lighting still has to be sold, however. Lighting customers "have to be shown". First, they have to be shown why their present lighting is inadequate. Second, they want to see for themselves what lighting improvements result from relighting, or what they receive for their money on new lighting installations. Portable type measuring instruments have been developed for field use and are available for this purpose.

The most common type of measuring instrument for the application lighting engineer is the footcandle meter. It measures lighting intensities in "footcandles" directly on a footcandle scale. Such instruments are variously called "footcandle meters", "light meters" and "illuminometers".

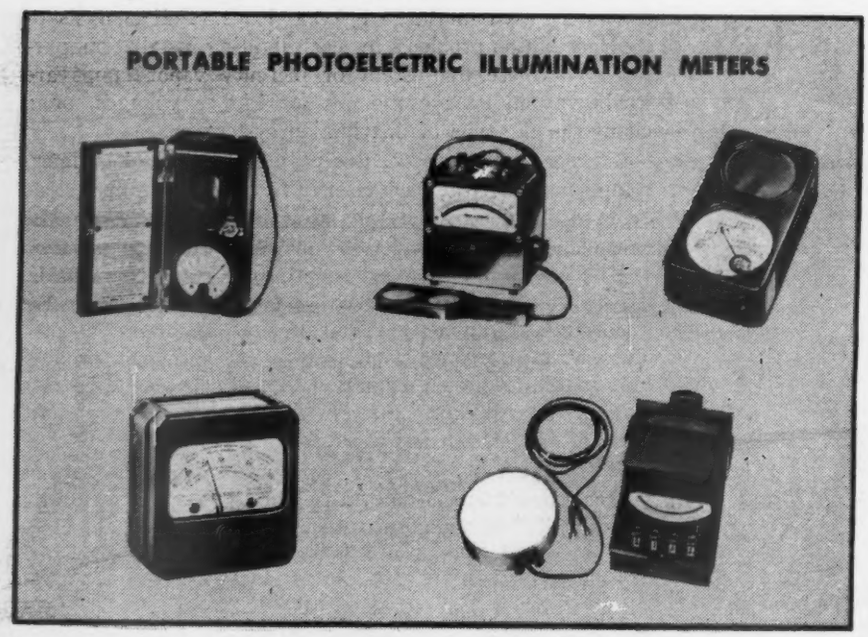


They are portable instruments, and use light-sensitive photoelectric cells. While the spectral response of these photoelectric cells does not coincide with the light sensitivity curve of the eye, these meters are adequate for general commercial use when light source correction factors, which are available from the various meter manufacturers, are applied to readings obtained under any specific type of light source. Several types of available light meters are illustrated below.

Other important measuring instruments for the illuminating engineer, which aid him in analyzing the lighting problem or lighting result include the visibility meter, brightness meter and voltmeter, all illustrated above.

It is important to record impressed voltage at the lamp or at the ballast when making footcandle intensity readings, if an intelligent analysis of the efficiency of the lighting system is to be expected. The voltmeter is therefore considered an important measuring instrument for the lighting engineer. It should be of the portable type and equipped with two scales, one to indicate voltages up to 150 volts, the other to indicate voltages up to 300 volts. To be of real value, every lighting report showing footcandle intensities should also show the impressed voltages existing when the footcandle readings were made.

The above instruments are considered necessary tools for obtaining complete information on lighting installations. They are primarily for use by the application lighting engineer in making field reports covering either old or new lighting jobs. Data thus obtained is germane to all *Planned Lighting* applications.



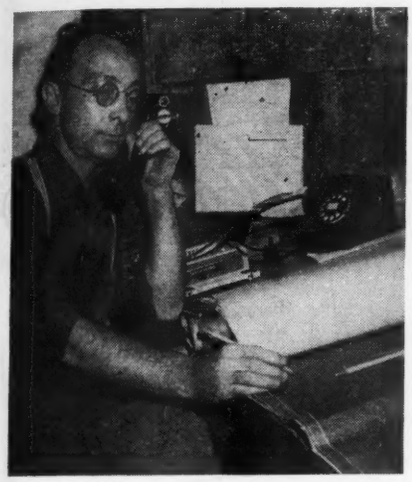
BRIEF ARTICLES about practical methods of installation and maintaining electrical wiring and equipment and up-to-date estimating and office practices. Readers are invited to contribute items from their experience to this department. All articles used will be paid for.

Practical Methods

Inter-Com System Speeds Installation

CONSTRUCTION

One of the prime functions of a job superintendent is to keep in constant touch with the various crews working on an electrical construction project. It's not easy on a multi-story building like the 18-floor new Terrace Plaza Hotel Building in Cincinnati, Ohio, unless some means of intercommunication is established.



Ray Bertke, job superintendent for Bertke Electric Co., at the new Terrace Plaza Hotel Building in Cincinnati, Ohio, relays some last minute dimensional changes to electricians working "on the pour" on the 18th floor. Inter-com phone is on the wall; Bell System unit on desk.

Mechanic George Grad receives an inter-com call on one of the upper floors and relays the message to the floor foreman.

To expedite their work, Bertke Electric Company, Cincinnati electrical contractors on the above project, installed an intercommunicating telephone system between their field office in the sub-basement and the various floors of the building. Sets are installed on each floor or alternate ones, depending upon the need. Simple wall units with cradle phones and pushbutton signal are used. Communication can be made between any floor.

To overcome normal construction noise on the various floors, signal horns instead of the conventional bells are used. Each floor is assigned a signal, as is the field office. Other trades working in the building also use the system and have developed their own set of signals.

Biggest asset, according to Ray Bertke, job superintendent, is the ability to quickly relay last minute changes on plans that come into the front office. Prompt attention can be directed to requests for material and special items from the floors above, particularly during the concrete pouring phase. And the mechanics are heartily in favor of the system, especially those who are in the "upper regions" and have to climb stairs to get to their work areas.

Storage Box For Hardware

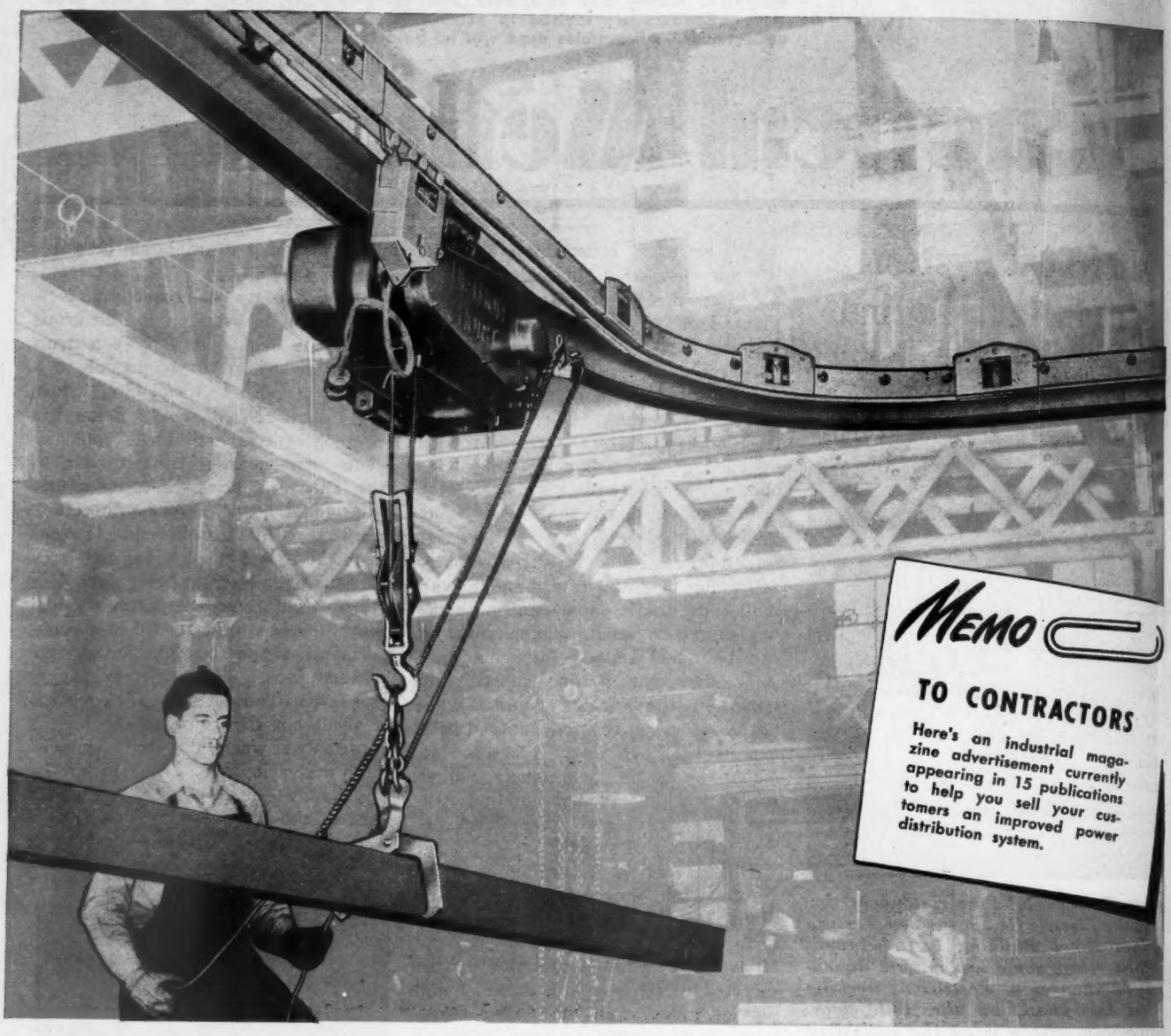
CONSTRUCTION

Electrical installation work often calls for the use of tools, equipment and hardware not commonly classed as electrical, yet of definite assistance to the electrician. In this hardware line, such items as wood screws, stove bolts, machine and Parker screws, nails and washers are of frequent assistance. These items, as well as rawl plugs, toggle bolts, tape, solder paste, cartridge and plug fuses should be available on all jobs.

Dave Epstein of Brooklyn, New York, after 30 years in the electrical installation field, finds that such items can be carried from job to job in a compact wooden or metal box. Since large quantities of these items are rarely required, individual compartments need not be larger than a 4-inch cube. A box measuring a foot square and 4 inches deep, therefore, can be divided into nine cubicle compartments. A hinged cover and latch prevents articles from being jarred or spilled from their compartments and allows the box to be turned in a vertical, space saving position for storage between jobs. The monetary saving of a few nails or washers for each job is small but the value of the box is appreciated when the job demands these minor items and, due to having this handy storage box conveniently located, the items are available.

Pentagonal pull-box in a tight squeeze between concrete beam and ejector line in sub-basement of new Terrace Plaza Hotel Building in Cincinnati. Designed and installed by Bertke Electric Co., it eliminates awkward offsets, carries feeders up to store area. Trapeze conduit hanger near one side helps support box weight.

How to get power without pull


MEMO
TO CONTRACTORS
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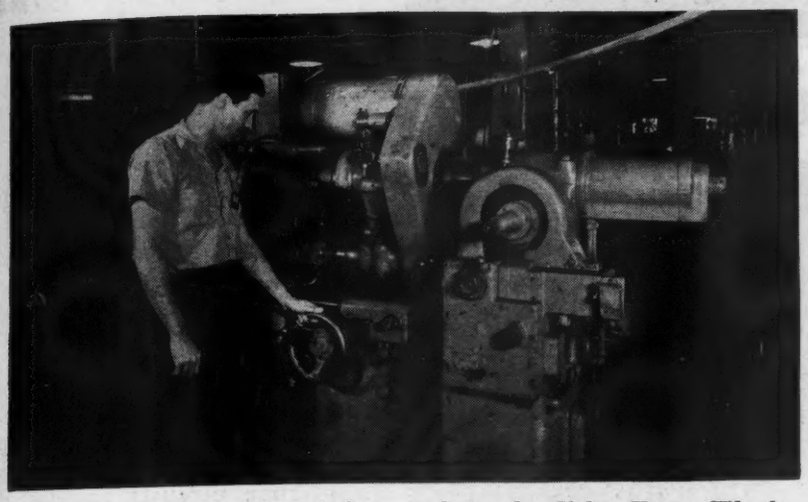
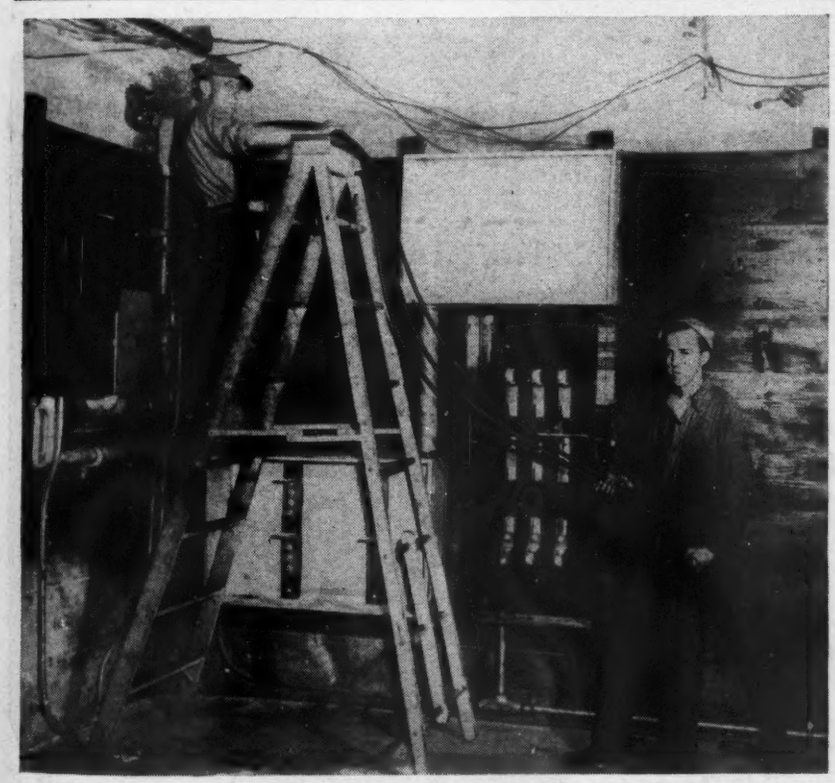


One of ten automatic grinders used in the Kelsey-Hayes Wheel Company plant in Detroit is adjusted while grinding the insides of an aircraft engine piston sleeve. Machines were rewound four years ago, using Fiberglas insulation in place of Class A, and have operated without failure at 50 percent overload since the rewinding operation was completed.

Overloads with Fiberglass Insulation

MAINTENANCE

Rewinding ten automatic grinders with coils insulated with Fiberglas made it possible to increase the capacity of these machines by 50 percent in the plant of Kelsey-Hayes Wheel Company, Detroit. These machines are used to grind the insides of aircraft engine piston sleeves and are 3600 rpm., 3-phase, 220/240-volt units. The original rating of the motors was 10 hp. each. The initial rewinding job was completed in 1943 and replaced the original Class A insulation. Although the motors have remained in constant use since that date, no failures have resulted under the overloaded conditions and the machines are still rendering satisfactory service.



Electrician Joe Blair (ladder) and James Starka, helper, Stark Electric Company, Baltimore, get ready to pull three No. 3/0 cables at Swindle Bros. glass plant, during re-wiring operations.

Voltage Stabilizer

PRODUCTION

Varying voltage conditions have been eliminated at the Charles M. Falk Lithographic Plant in San Francisco through the application of a General Electric voltage stabilizer. Print and negative quality has been noticeably improved since the installation. Utility power, when influenced by other loads in the plant, varied from 190 to 260 volts but voltage stabilization is now constant at 230 volts.

Research on the part of the Falk Company indicated that black and white negatives did not have equal densities for equal exposure times and true colors were affected in color negatives. These variations were traced to voltage variations at the light sources, caused by changes in electrical loads throughout the plant. The new stabilizer, a 5000-va. transformer network device, delivers a constant flow of current and controls the lighting circuit used in the photographic processes. Definite savings have resulted due to reduced negative spoilage and lower time losses.

Charles M. Falk, Lithographer, examines a positive plate after processing. Constant current to photographic light circuit is maintained at 230 volts by means of General Electric voltage stabilizer.

The installation of this stabilizer marks the initial application of such a unit in the lithographic field. With the greatly improved quality of both negatives and prints, the unit is being considered for wider use. With the stabilizer connected, the influence of other electrical loads on the voltage output has been completely eliminated. Color quality and negative density are now constant for like exposures.

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. . . to FEDERAL NOARK multi-breakers

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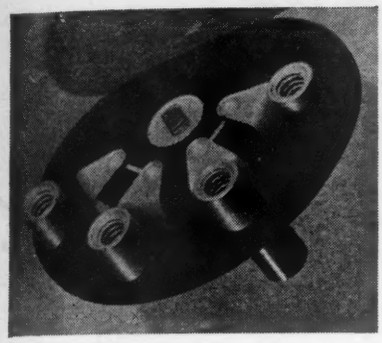
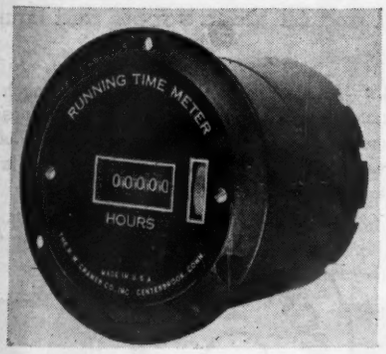
THESE ANNOUNCEMENTS of new equipment are necessarily brief—for more detailed description, sizes, prices and other data write to the manufacturers' advertising department, tell them in what issue of ELECTRICAL CONSTRUCTION and MAINTENANCE you saw the item and they will send full details to you.

Equipment News



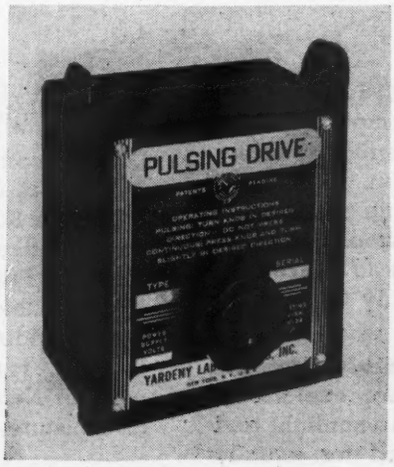
Motor Voltage Change Switch

A motor voltage change switch has been developed which makes possible the universal application of fractional horsepower motors. Selection for operation on 110 volt or 230 volt a-c line source is accomplished by switching the field windings at initial installation when under no load conditions. As a line voltage setting device, change switch has two positions—one connecting two field windings in parallel for 110 volt operation, and the other connecting the two windings in series for 220 volt operation. It is equipped with terminals that may serve as junctions for the line and field winding loads. P. R. Mallory & Co., Inc., 3020 N. Washington St., Indianapolis 6, Ind.



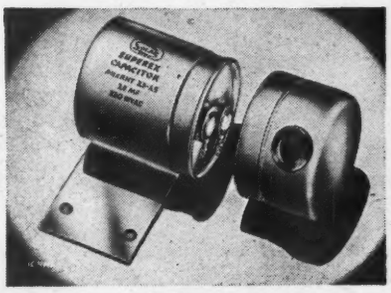
Time Meter

The new time totalizer or running time meter features a counter that can be reset to zero. Designed for use on a-c circuits, meters automatically register total operating or idle time of any circuit, machine or system to which connected. Typical applications include to indicate operating time of vacuum tubes so that replacement can be made before failure occurs; to indicate total operation hours of automatic pumps and machines, forecasting need of servicing and parts replacement. Meters with reset feature are available in three models. Type E5, suitable for table use. Type E6, enclosed in metal housing arranged for conduit connections, complete with hinged cover and hasp for padlocking. Type E7, is a 3¾-inch diameter instrument for flush panel mounting and is equipped with knob reset accessible from front. Available for 60 or 50 cycle frequency, 110 or 220 volts. The R. W. Cramer Company, Inc., Centerbrook, Conn.



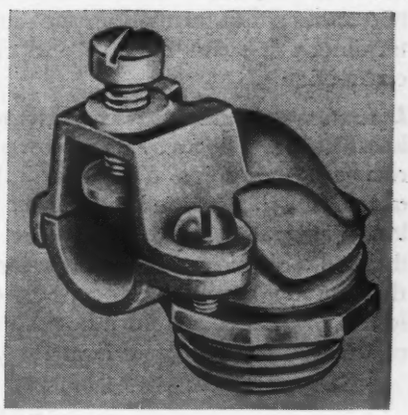
Pulsing Drive

The pulsing drive is a new device for controlling electrical motors. It responds to the operation of a single knob. When knob is rotated in one direction, pulsing drive closes selectively one of two circuits for very short periods of time repeated at a rate dependent upon the speed of the knob rotation. A slow, clockwise rotation of control knob causes a series of short electrical pulses to be applied to the motor winding, corresponding to the desired direction of rotation, and results in a corresponding motor motion in small increments. Drive is suitable for controlling all standard types of electric motors or magnetic valves. Yardeny Laboratories, Inc., 105 Chambers Street, New York, N. Y.



Capacitors

A new design of a-c paper capacitors for small motors has been introduced. A "Snap-Cap" arrangement and heavy gage containers enable these new Type ANXRHT units to comply with Underwriter's Laboratories requirements. The removable "Snap-Cap" permits motor leads to be soldered directly to the capacitor terminals and avoids the need for splicing connections between capacitor and motor winding. Solar Manufacturing Corporation, 285 Madison Avenue, New York 17, N. Y.



Cable Connector

This new fitting is a 90 degree angle connector specially designed for the new 1946 Code PVX cables. It has a "shoehold" cable grip that tightly locks the cable into the connector without damaging the cable. Designated AC-15, the new connector accommodates 14-2, 14-3, 12-2 and 12-3 cables. Gedney Electric Company, 1270 Sixth Avenue, New York, N. Y.

install RoMarine - RoPrene* cable

FOR ENTRANCE AND POWER DISTRIBUTION IN INDUSTRIAL PLANTS

RECOMMENDED INSTALLATIONS

1. Direct earth burial
2. Aerially
3. In ducts or conduits
4. In open air on racks

*Approved as Type USE (Style RR) by Underwriters' Laboratories for Underground Service Entrances.

Ease of handling cuts installation costs. RoMarine-RoPrene, compared to lead sheathed cable, is light and consequently easier to handle. When installed in conduit, its smooth, low-friction, RoPrene (Neoprene) sheath pulls easily . . . with no braid to bind or stick. Its simple construction makes RoMarine-RoPrene easier to splice and terminate. It strips quickly and cleanly for positive connection.

Immunity to elements facilitates multi-purpose installation. Because its RoPrene (Neoprene) sheath resists flame, acids, alkalies, oil, heat, sunlight and abrasives, RoMarine-RoPrene is good for equally long service life, underground or in open air. Here, then, is a *single* cable for both service entrance and distribution circuits. The economy of open rack installation, or direct earth burial, without need for conduits or ducts, represents savings for you. Further, open rack installation permits easy tap-offs when it comes to rearranging circuits or increasing power outlets.

Quality construction means longer life. RoMarine-RoPrene is designed for extra long service at 600 volts. The RoMarine insulation is a long aging compound with excellent electrical stability in water. The tough RoPrene sheath of Neoprene compound is equal in thickness to IPCEA requirements for lead . . . providing extra protection against mechanical injury . . . to say nothing of the well recognized resistance of Neoprene to industrial contamination such as moisture, acid and oil laden vapors and liquids.

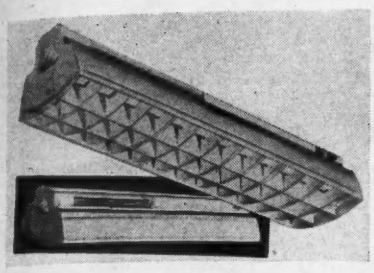
☆ ☆ ☆

SIZES AVAILABLE—Single conductor in sizes 14 through 4/0 AWG; multiple conductor in sizes 14 through 2 AWG. Savings can often result through use of the required number of single conductors as against multiple conductor construction. The original cost is less and they are easier to splice and terminate

FROM BAR TO FINISHED WIRE

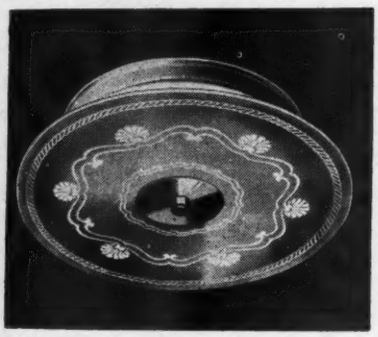
ROME CABLE CORPORATION

ROME • NEW YORK



Fluorescent Fixture

A newly designed fluorescent unit, known as "Schoolmaster", especially built for use in classrooms, has been announced. In addition to the 60 percent downward and 40 percent upward light diffusion for schoolroom use, the unit features a new application of a built in germicidal lamp, which is not visible if the fixture is hung at ordinary lighting levels. Fixture is so designed that the heat of the ballast causes circulation of air in the room to pass over the germicidal lamp. Other features include a free swinging louver for easy maintenance and a coupler button for continuous row mounting. Unit is available with or without the germicidal unit. Leader Electric Company, 3500 North Kedzie, Chicago 18, Ill.

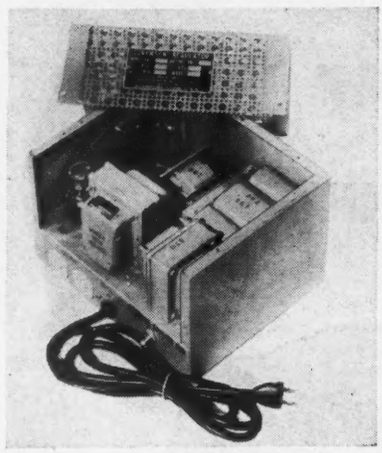


Lighting Fixture

New shielded Circline combination ceiling fixture and wall bracket with 32 watt Circline lamp has been introduced. It produces soft diffused overall lighting without glare for general illumination in moderate sized rooms. Recommended for living, dining, sun or bedrooms, or in dinette or recreation room. Also as wall bracket in lobbies, foyers, corridors; between doors, in panels; or in theatres, hotels, banks, shop and other public buildings. Made of formed steel with eggshell, baked enamel finish. Shield is of frosted glass with white design fused on. Moe-Bridges Corp., Sheboygan, Wis.

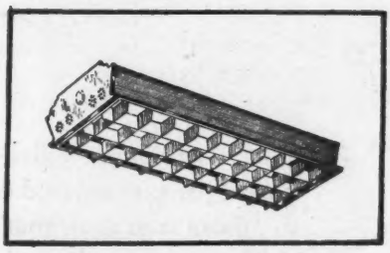
Oil-Resistant Compound

An oil resistant compound for splicing electrical wire has been announced. The new compound is made of neoprene rubber combined with special synthetics. It is recommended for use on any electrical circuit coming in contact with oil. It is distributed in the form of tape 30 feet long, three quarters of an inch wide and .030 inch thick. United States Rubber Company, Rockefeller Center, New York, N. Y.



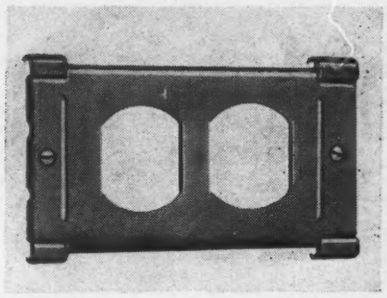
Voltage Regulator

A general purpose portable a-c voltage regulator, designated Model 150, featuring electronic control circuits and designed specifically for component applications with electrical equipment utilizing light loads, has been announced. Unit has an input voltage range of 95 to 125 volts a-c with an output of 115 volts. Regulation accuracy is ½ of one percent and maximum harmonic distortion is five percent. Maximum recovery time is six cycles. Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Conn.



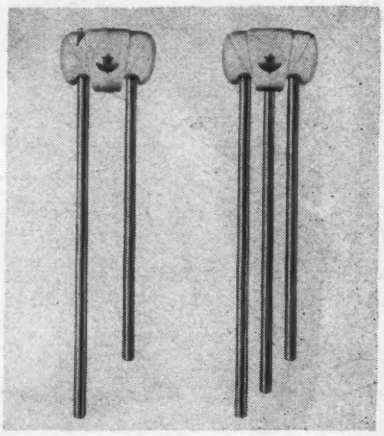
Fluorescent Fixtures

This new fluorescent fixture known as the "Hingemaster" is available for either four 20 watt or four 40 watt tubes and is made with either a louvered or plain glass bottom. It is claimed that the maintenance and installation time is cut in half by offering a hinged glass bottom which will drop to either side allowing greater accessibility for changing tubes, cleaning and other maintenance, and a hinged fixture body which permits access to ballast and sockets and facilitates hanging or repairs. Fluorescent Fixtures of California, 2779 Folsom Street, San Francisco, Calif.



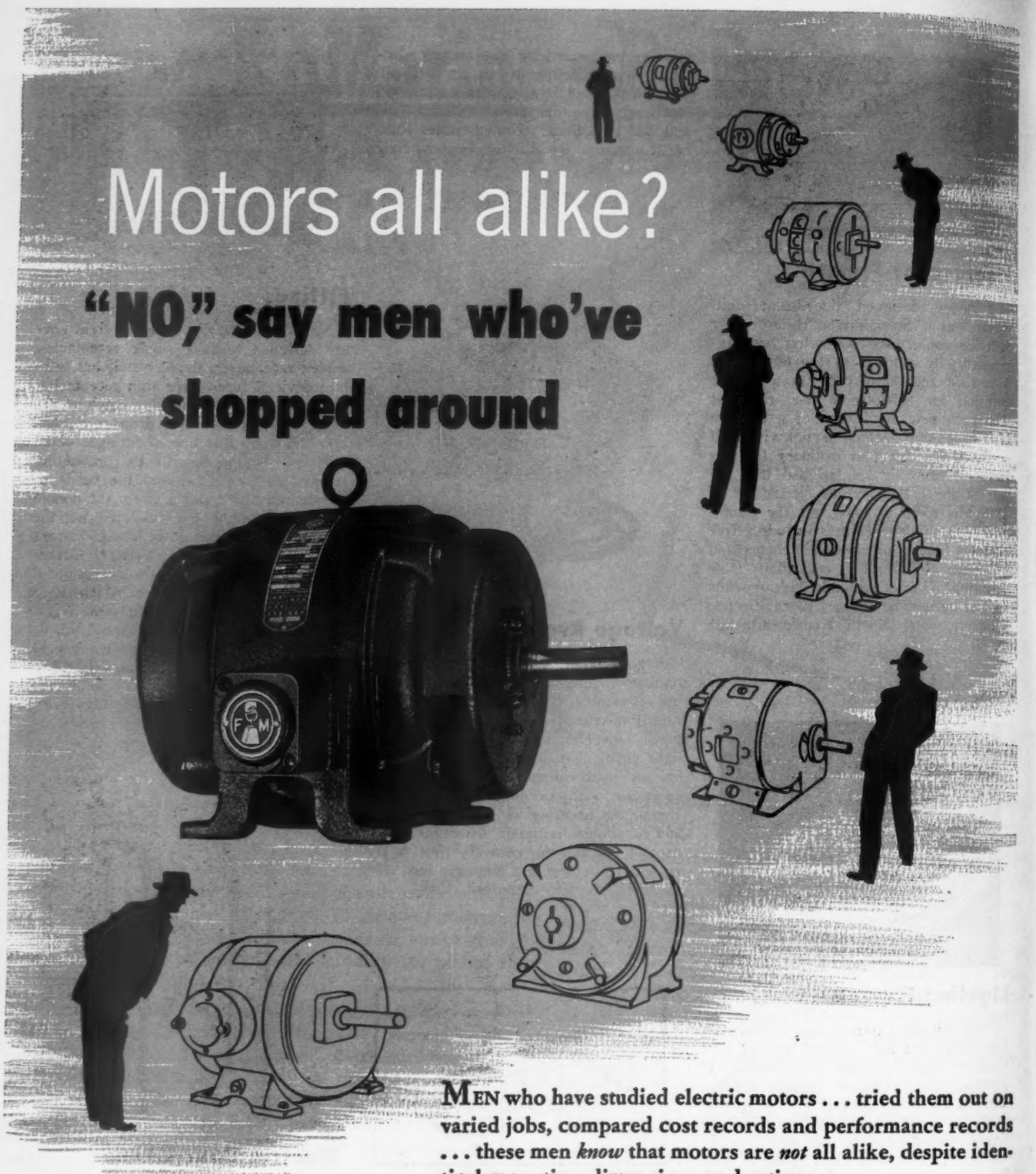
Fittings

No. 300 raceway, a series of eight covers designed to take single receptacles, duplex receptacles, tumbler switches, surface devices, screw type sign receptacles, surface type sign receptacles, condulet devices, and fixtures and drop cords has been added to this line of fittings. Each cover is equipped with two mounting straps which snap around the beads of the raceway base and perform the double duty of providing the mounting for the device and for the cover itself. Straps take up no space in the raceway. Covers are 4⅝ inches long with the exception of the condulet device cover which is 5 inches long. Capacity of No. 3000 Wiremold with devices in place is six No. 8; eight No. 10; ten No. 12 and ten No. 14 Type R or RH conductors; and eight No. 6; ten No. 8; ten No. 10; ten No. 12; and ten No. 14 Type T or RU conductors. The Wiremold Company, Hartford 10, Conn.



Electric Door Chime

The "Vanguard" electric door chime is for use in home, office, studio or shop. It is available in two styles: "Vanguard 3" and "Vanguard 2". The "Vanguard 3" has three long tubes of brass which are 1½ in. in diameter. Plastic housing is in antique ivory, with gold tulip medallion. Two notes announce callers at front door, one note for rear door. The "Vanguard 2" is identical in design and tone with "Vanguard 3" having two tubes instead of three. It operates on existing wiring or any 8 to 10 volt transformer. Size of chime is 9 by 41 by 2½ inches. Mell-O-Chime and Signal Corp., 119 S. Jefferson St., Chicago 6, Ill.



MEN who have studied electric motors . . . tried them out on varied jobs, compared cost records and performance records . . . these men *know* that motors are *not* all alike, despite identical mounting dimensions and ratings.

They know, for instance, that Fairbanks-Morse motors consistently demonstrate superior stamina where the going is tough. That's largely because of an exclusive combination of features which includes indestructible Copperspun rotors, prewound stators with long-lived insulation, ball bearings, crossflow ventilation that bans hot spots, and complete protection against falling objects and dripping liquids, regardless of mounting position.

For full information about motors that are different in ways profitable to you, write Fairbanks, Morse & Co., Chicago 5.

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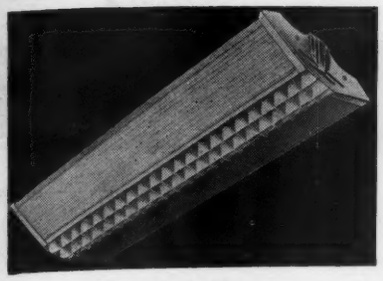
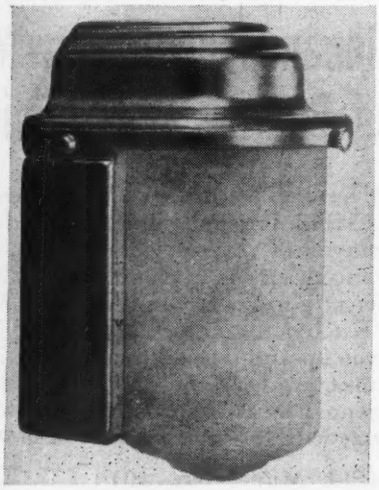
Pumps • Scales • Magnetos • Stokers • Railroad Motor Cars and Standpipes • Farm Equipment



Fluorescent Unit

A new line of commercial fluorescent luminaires has been announced. "The Vanguard" is a four lamp, 40 watt fixture, with glass size panels to open, giving easy access to cleaning and relamping. Slotted end-sections are fitted with glass panels to permit a soft glow of light, thereby eliminating dark ends. Unit is designed for either suspension or surface mounting, either in single units or continuous rows. It is available with canopy and stems. Also available without louver, but with full width glass side panels. Bright Light Reflector Company, Bridgeport, Conn.



Aluminum Wall Bracket

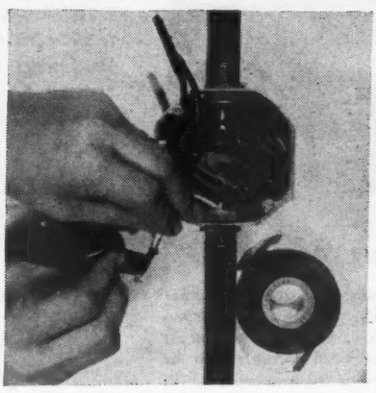
This new lighting fixture is available for porch or terrace as well as indoors for bathroom or halls. Unit is finished in graytone, coppertone, black or ivory. It is complete with cylindrical frosted, etched, enclosing glass, socket and mounting strap. Steber Manufacturing Co., Broadview, Ill.

Baking Varnish

This all purpose insulating varnish, Synthite AJR-7, is for use on all types of wound coils. It can be applied by either atmospheric dip or vacuum impregnation and is effective whether baked under infrared or in conventional gas or electric heated ovens. It has a high degree of dip tank stability and is easily handled in both production and repair shop treating cycles. Varnish may be obtained in all standard containers from one gallon cans to 55 gallon drums. It is especially adapted for use on all modern types of coated magnet wire such as Formvar, Formex, Nylon and glass. John C. Dolph Company, 1060 Broad Street, Newark 2, N. J.

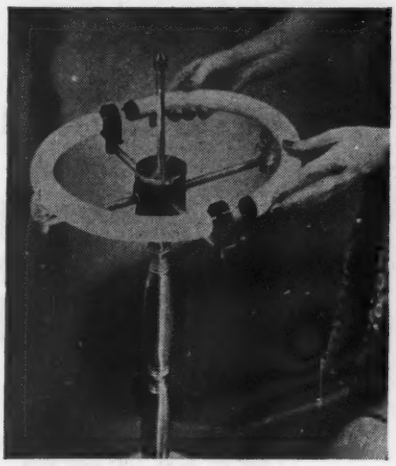
Fluorescent Lighting Fixtures

Luminette No. 906, a fluorescent lighting fixture that opens with a light fingertip touch, has been introduced. Called the Finger-Tip Control, advantages claimed are internal parts can be dusted quickly and easily; used lamps can be replaced easily. It has a Neo-Rex plastic shield. Built for surface mounting installation, it is wired for low-powered or high-powered ballast. Unit operates on 110-125 volts, 60 cycles a-c or 220-250 volts 50 cycles a-c, using four 20-watt fluorescent lamps. Neo-Ray Products, Inc., 313 East 22nd Street, New York, N. Y.



Tape

This new "Scotch" electrical tape, with Vinyl plastic backing, combines the electrical insulation of rubber tape and the mechanical protection of friction tape, in a single wrapping operation. Tape is weather-resistant and has a dielectric strength of 1,000 volts per mil. It is thinner than either rubber or friction tape. Thicknesses of the four varieties range from seven to twelve mils. Colors are yellow, white and black. Minnesota Mining and Manufacturing Co.



Fluorescent Lamp

A new semi-circular fluorescent lamp has been introduced. Designated "Circlarc" it is for table and floor lamps, for wall and ceiling fixtures, and for merchandising displays. It is an 18 watt tube curved to form a half circle 12 inches in diameter. It has a life expectancy of 2,500 hours at three hours average burning for each start. A two-pin plastic base at each end of the semi-circular lamp connects it to the electric current. Westinghouse Lamp Division, Bloomfield, N. J.

Switch

"Switch-O-Lite" consists of a single pole, single throw, magnetically operated latch type relay fuse holder and terminal board. It is housed in a cast aluminum enclosure, providing a weatherproof container. It is rated at 115 volts, 60 cycle a-c, 10 ampere, non-inductive, with an operating coil suitable for continuous duty. Each time the relay coil is energized it causes the switch to change to the opposite position. The next time the coil is energized it will return the switch to the original position. Each resultant impulse energizes the relay coil, which latches either in an on or off position, switching the light either on or off. The container has two apertures on top and bottom, and is fitted with two removable plugs which permits entrance mountings to be made either from top or bottom. Hoffman Engineering Corporation, Anoka, Minn.

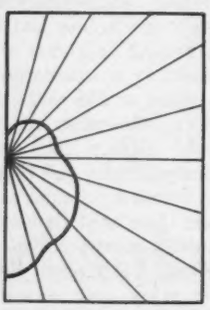
Miracle of Modern Kitchen Lighting

THE SPECTACULAR NEW

MITCHELL

"CIRCLE-PLUS" KITCHEN LUMINAIRE

PERFECTION IN KITCHEN LIGHTING



The light chart tells the story! The incomparable MITCHELL CIRCLE-PLUS Kitchen Luminaire delivers more "seeing" light than any conventional incandescent or fluorescent fixture on the market. And it's the kind of illumination every American housewife has dreamed of for her kitchen —abundant light without glare, without shadow. Here, at last, is the modern lighting that lives up to the convenience and smartness of modern equipped kitchens. Insist on the best kitchen lighting ever made available—the MITCHELL CIRCLE-PLUS Luminaire!

Circline Fluorescent *plus* Incandescent...New Magic in Lighting Beauty and Efficiency

It's *new!* It's *different!* It's a dream of a kitchen fixture come true! MITCHELL ingenuity has combined the outstanding advantages of the new Circline Fluorescent lamp with advanced incandescent design to create a miracle of modern lighting. The ingenious MITCHELL CIRCLE-PLUS Kitchen Luminaire provides *for the first time,* smooth, even up-and-down illumination . . . glareless and abundant. And all the magic of this superb lighting is presented in a masterfully styled fixture of flawless beauty, worthy of America's finest homes.

The MITCHELL Model No. 4014 CIRCLE-PLUS Kitchen Luminaire uses the new 32-watt Circline Fluorescent lamp with latest ballast and starter. Incandescent illumination is provided by a 100-watt light bulb, shielded by a streamlined white ceramic-glass bowl, scientifically designed for maximum diffusion of glareless light. The graceful metal flange is beautifully finished in matching chip-proof baked White Enamel, and is equipped with handsome clear plastic holders for the Circline lamp. Completely wired. Connecting fittings supplied for permanent installation. Knockout provided for pull-switch. Unit measures 10⅞" in diameter, 7¾" high overall. For 110-125 volts, 60 cycles A. C. only. Packed individually. Shipping weight, 11 lbs.

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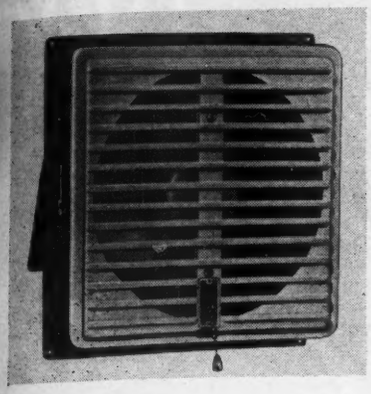
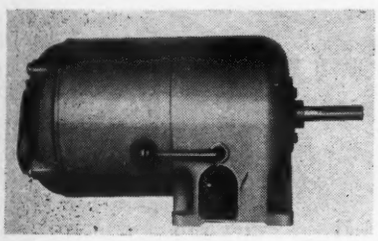


Ventilator

An exhaust-type ventilator designed for use in kitchens, laundries, recreation rooms, and bathrooms in homes, and in offices, reception rooms, dressing rooms and rest rooms in commercial buildings has been announced. It features a single automatic control, high efficiency in air movement, and easy installation and maintenance. One control opens and closes the outside door, and starts and stops the fan automatically. Air in average size kitchen is changed every three minutes. Static air spaces, corners, elbows, flanges, and other obstructions are eliminated. Standard unit voltage is 115 volt 60 cycle, a-c. F. A. Smith Manufacturing Co., Inc., 255 N. Union Street, Rochester 7, N. Y.

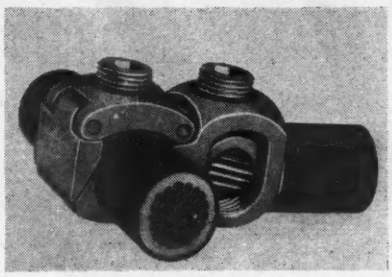


Gearshift Drive

A new 4 speed, Type R gearshift drive, with integrally mounted single phase motor is available. Type R units are built to drive machinery requiring selective speeds and are available in sizes of ½ hp. at 1200 rpm and ¾ hp. at 1800 rpm. Gear ratios of the Type R are 1 to 1, 1.33 to 1, 2 to 1 and 4 to 1. Units will operate on 115 and 230 volts a-c, 50 and 60 cycle. The Lima Electric Motor Company, 2201 Findlay Road, Lima, Ohio.

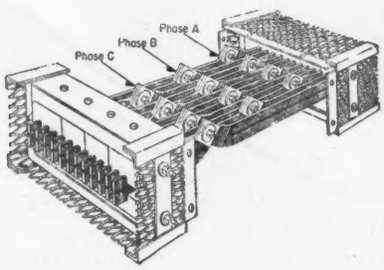
Slimline Lamps

The operating range of the G-E slimline lamps has been extended to 300 milliamperes, with no change in rated lamp life. They previously had a current range of 100 to 200 milliamperes. By increasing the current rating of the lamp, more light per foot is obtained. Operation of the lamps at the higher current ratings will be found particularly applicable for industrial and commercial lighting fixtures, in show cases, wall cases, show window lighting or wherever high light output per foot of lamp is important. In order to put more current through the slimline lamps, it is necessary to use ballasts made especially for this higher rating. General Electric Company, Nela Park, Cleveland 12, Ohio.



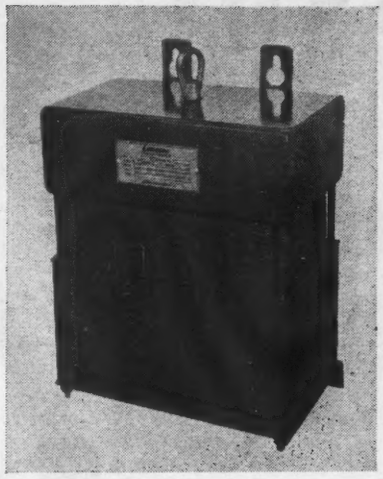
Solderless Connectors

A complete line of solderless connectors, designed for wire sizes from No. 12 to 2,000,000 CM, are now offered with a special "Cadux" plating which makes them suitable for aluminum building wire connections. It is claimed that these connectors assure positive, permanent connections on aluminum. The Cadux plating eliminates normal electrolytic action which usually takes place between copper and aluminum. O. Z. Electrical Manufacturing Company, 262 Bond Street, Brooklyn 2, N. Y.



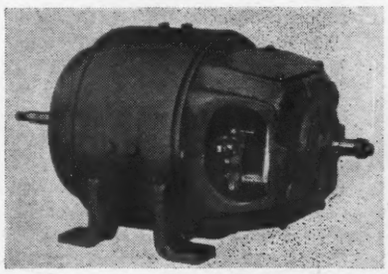
Feeder Bus

This new Universal feeder bus is specifically designed for conducting long runs of large alternating currents. Available in 800, 1000, 1350, 1600 and 2000 amp. capacities; two pole single phase, 3 pole 3 phase and 3 phase 4 wire. Protected by an expanded steel mesh on all sides, the busbars are interlaced, wrapped and insulated. It can be mounted or suspended in industrial or commercial plants, in the conventional way, or by means of connecting to insulator frame support bolts which are spaced every 20 inches. National Electric Products Corp., Chamber of Commerce Bldg., Pittsburgh, Pa.



Transformer

A complete line of power and lighting transformers in a wide range of ratings and sizes is available. They are rated from 1 to 15 kva. and totally enclosed for outdoor and indoor use. Transformers of standard rating are made to operate at rated frequency, and on any of the rated voltages up to 600 volts. All units include a wiring compartment, which has knockouts to facilitate any conduit arrangement. Lindberg Engineering Company, Transformer Division, 2444 W. Hubbard St., Chicago 12, Ill.



Railway Auxiliary Motors

A new line of d-c railway auxiliary motors for driving blowers, battery-charging generators, and air compressors on subway cars, trolley coaches, and similar vehicles operating on 600 volt d-c systems has been announced. Available in sizes from 1 to 4 hp., the motors have full load speeds ranging from 1150 to 1925 rpm. The complete line has ball bearing construction with either totally enclosed or dripproof enclosures. Special features include a specially designed coil to prevent chafing of the insulation as a result of thermal expansion and vibration; closed-type terminals for all internal connections; and a shockproof brush rigging. Motors available with either series or compound windings. Full voltage starting is used with both series-and compound-wound types for sizes up to and including 3 hp. General Electric Company, Schenectady, N. Y.

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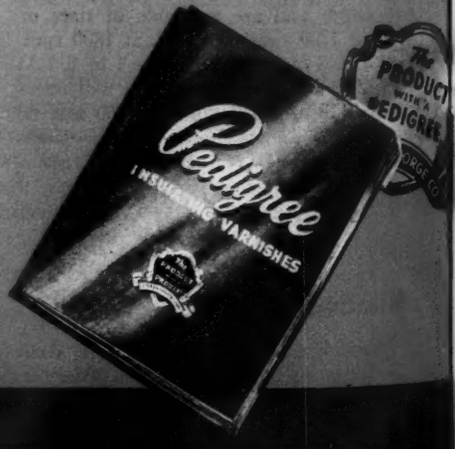

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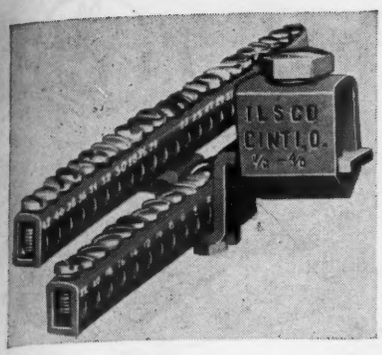
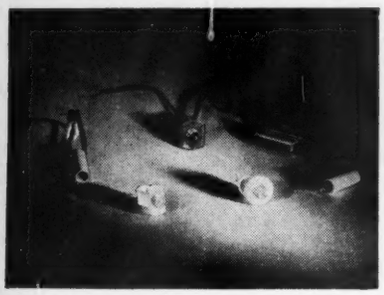


Neutral Bar

A new type of neutral bar has been announced. Panel manufacturers can buy the exact size neutral bar required for a particular installation with the definite number of outlets needed. In the 225 ampere illustrated, the bar provides 42 outlets which are all 1-63/64 inches apart. This distance between outlets is standardized on the three sizes of neutral bars manufactured which are 70, 125 and 225 amperes, regardless of the number of outlets. They have been approved by Underwriters as follows: 70 ampere for a maximum of 14 outlets, 125 ampere for maximum of 30 outlets and the 225 ampere for a maximum of 42 outlets. Ilsco Tube & Products, Inc., Mariemont, Cincinnati, Ohio.



Indicator Lights

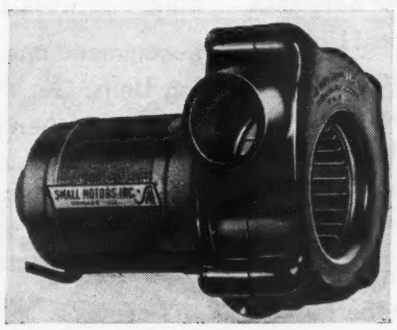
A new line of standard neon-glow indicators has been announced. Units are designed to be used primarily as a subassembly suitable for any electrical equipment requiring a lighted indicator device. Units are composed primarily of a high heat-resisting outer housing provided with suitable mounting bracket, which encases a neon glow lamp (permanent or replaceable) and proper resistance for operating on voltages of 70 volts and upward—a-c or d-c. They are provided with or without shielded lead wires. American Electronics Corporation, 226 No. Fourth Street, Columbus, Ohio.

Sparkproof Cable

A new cable that will not spark when short circuited has been developed to aid in the prevention of coal mine explosions. The new feature of the cable is a fine strand of copper wire over the insulation of the positive conductor. In the event of damage to the insulation the fine wire catches incipient current leakage before an arc can occur and carries it through the coil of a sensitive circuit breaker to ground. This type of cable is used to carry power to heavy equipment employed in digging and transporting coal. United States Rubber Company, Rockefeller Center, New York, N. Y.

Flashlight

The new Rub-R-Lite "K2" flashlight operates on a new principle. Claimed to be an innovation in flashlight design, all working parts, including approved bulb-ejector mechanism, are contained in a small "sealed-in-head" unit, which is popped in or out of the steel lined neoprene case, whenever bulb or batteries are to be changed. It has a one-button switch. Dropping or throwing flashlight, it is claimed, will not damage it. Submerging it in water or oil cannot hurt it. Resists heat and cold. It is a non-conductor that can be used around high power lines and electrical equipment. There are no exposed metal parts. It has Underwriters' approval for Class 1, Group D, hazardous locations. Lennan Lights, Inc., Burbank, Calif.

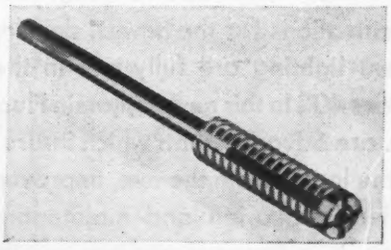


Blower

The Bantam B-2 blower, for ventilatting and cooling electronic tubes, projectors and other units is available. It delivers 32 cfm. and is powered by a universal fractional horsepower motor built for efficient, long life performance. It operates on 110 volt, 60 cycle, a-c and d-c. Unit is 5⅛ by 3½ by 3¾ inches. Small Motors, Inc., 2076 Elston Ave., Chicago.

Arc Welders

A new line of industrial type a-c transformer welders has been announced. The large illuminated current indicating scale is uniformly calibrated so that the extra large figures are evenly spaced from minimum to maximum welding heat settings, instead of crowded at one end and wide open at the other. The dial is of translucent plastic, illuminated from within by a 110 volt lamp mounted in a standard base, making it easy to read from a distance in either light or dark locations. These welders are of the moving coil type with no adjustable magnetic paths. All coils are made of glass covered copper strap and all insulation is Class B. Capacitors are built in the units for power factor correction. The Hobart Brothers Co., Hobart Square, Troy, Ohio.



Drill Bits

A series of drill bits for boring holes in concrete, tile, brick or marble has been announced. These new bits can be used in connection with any standard automatic drill. Diamond dressed cutting tips are set in blunt end of bit at correct angle. Available in sizes ranging from ¼ in. to 2 in. in diameter. There are four cutters at the proper cutting angle in the outside rim of the bits of ¾ in. or larger. Bits clean their holes as they drill. Bits of smaller than ¾ in. have three cutters. Rotary Concrete Drill Co., 650 Arroyo Parkway, Pasadena 2, Calif.

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The Use of Capacitors In Industrial Plants—Part I

A-c Systems Require Two Types of Current

W. C. Bloomquist
Industrial Power Division
General Electric Company
Schenectady, N. Y.

ALTERNATING-current equipment such as induction motors, transformers, fluorescent lights, induction heating furnaces, resistance welders, etc., requires *two* kinds of current:

1. *Power producing* (or "working") current, which is converted by the equipment into useful work such as running a boring mill, making a weld, pumping water, or hoisting coal. The unit of measurement of power produced is the Kilowatt.

2. *Magnetizing* (also called "wattless", "reactive", or "non-working") current, which is required to produce the flux necessary for operation of induction equipment. The unit of measurement of this reactive "power" is the Kilovar.

Therefore, most a-c systems require two commodities—kilowatts and kilovars. This article deals with the use of capacitors for supplying one of these —kilovars—in industrial plants.

Arithmetic of Alternating Currents

The arithmetic applicable to everyday life follows the simple rule of two plus two equals four. Instead of following such a simple rule, alternating-current unfortunately uses a principle derived from geometry. For example: if we have a load needing 80 amperes of kilowatt current and 60 amperes of kilovar current, the total current is found by using a right triangle, which gives a total current of 100 amperes.

For this condition the generators, main distribution circuits, transformers, and feeder circuits supplying the load would have to carry 100 amperes. However, if a capacitor which could deliver 60 amperes were installed at the load, all of the required kilovar current would be produced on the spot and the system, from the generator to the load, would carry only 80 amperes—the kilowatt current. Here we have a case where apparently $100 - 60 = 80$.

What is Power-Factor Improvement?

The ratio of working current to total current is called power factor.

Another definition of power factor, which is generally more useful, is the ratio of the kw. or working power to the total kva or apparent power. Thus power factor $= \frac{\text{kw.}}{\text{kva.}}$

For the case illustrated in Fig. 1, the power factor is 80/100 or 0.8 or, as it is sometimes expressed, 80 percent. After a capacitor is installed to supply the total of 60 amperes of kilovar current, the line power factor would then be 100 percent as only working current would flow in the line. Thus, the power factor may be improved by decreasing the kilovar current from the incoming line by supplying the kilovars near the load with capacitors. This is shown diagrammatically in Fig. 2a and Fig. 2b. The load draws 100 amperes from the supply circuit, but because part of the current is consumed by the magnetizing requirements of the load, only 80 amperes are actually being converted into useful work.

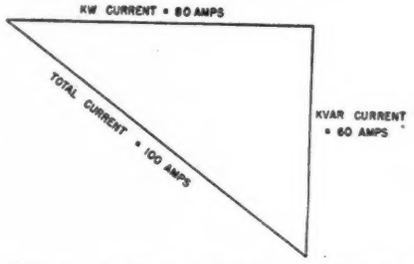


FIG. 1—Right triangle relationship for a-c calculations.

After a capacitor is added, the magnetizing current is supplied by the capacitor, so the supply circuit needs to deliver only 80 amperes to do exactly the same work. *No system capacity is wasted in nonproductive work.*

In Fig 2a it would appear that since the current supplied to the load is 100 amperes, and since only 80 amperes of this are being converted to useful work, the magnetizing require-

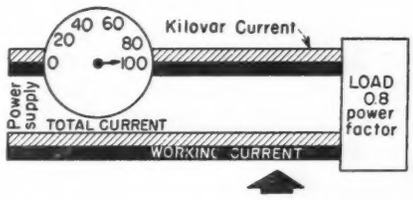


FIG. 2a—Because part of the current is consumed by the magnetizing requirements (kilovar current) of the load, only 80 amps. are actually being converted into useful work.

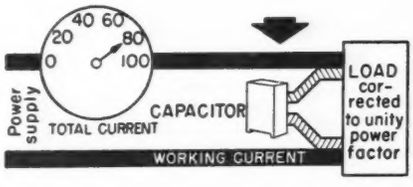


FIG. 2b—After a capacitor is added, the magnetizing requirement is supplied by the capacitor, and it is necessary for the supply circuit to deliver only 80 amps. to do the same work.

Large rack indoor capacitor equipment rated 1080 kvar., 4160 volts for plant power factor for a large foundry.

ment of the load must be the difference between the two, or $100 - 80 = 20$ amperes. Hence, it might further be assumed that a 20-ampere capacitor could be used to compensate for the magnetizing requirement. However, neither of these assumptions is correct, as illustrated by the triangle in Fig. 1 describing the arithmetic of alternating-current. The simple subtraction of the "working" current from the total current never equals the magnetizing current, an important fact to remember.

The actual calculation of power factor is illustrated by the following example:—

What is the power factor of the load on a 460-volt, three-phase system if the ammeter indicates 100 amperes and the watt-meter reads 62 kilowatts?

Since, in a three-phase circuit:

$$\text{Kva} = \frac{\sqrt{3} \times \text{volts} \times \text{amperes}}{1000}$$

$$= \frac{1.73 \times 460 \times 100}{1000} = 79.6$$

$$\text{Power factor} = \frac{\text{kw.}}{\text{kva.}} = \frac{62}{79.6}$$

$$= 0.78 \text{ or, as often expressed, 78 percent.}$$

The most common reasons for using shunt capacitors in industrial plants are:

1. Reduce power costs.
   This is the most common and important use.
2. Release of system capacity.
   Capacitors are economically justified to release system capacity and especially when the plant power factor is below 80 percent. This is especially important now in connection with increased industrial expansion because capacitors are available in shorter time than substation and associated equipment.
3. Reduce system losses.
   An *additional* benefit of capacitors.
4. Improve system voltage level.
   An *additional* benefit of capacitors.

Reduction in Power Costs

The most common and important reason for using capacitors in industrial plants is to reduce power costs when a power factor clause, or its equivalent, is part of the rate structure.

History of Power Factor Rate Clause

The history of the power factor clause goes back to the turn of the century. The early induction motors were slow speed and had a poor power factor, so power generation and distribution facilities quickly became overloaded due to the magnetizing kilovars. For example, at a load power factor of 70 percent, the kilowatts and kilovars are equal and the system can be utilized to only 70 percent of its kilowatt capacity.

Early utilities were mostly local affairs and transmission distances were short, but as transmission distances and loads increased it became even more important to transmit only the kilowatt, or pay load, instead of loading the system with magnetizing kilovars. Also, in order to maintain proper system voltage levels economically, the power factor must be relatively high.

Obviously, it requires larger facilities and more system investment to serve a low power factor load than a high power factor load of the same kilowatt demand. Therefore in order to compensate for the extra investment, utilities introduced the power factor clause offering a reduction in power billing for good load power factor. In addition to reducing power costs by improved power factor, the industrial obtains the added benefit of releasing some system capacity, permitting addition of load without investing in additional substations and distribution facilities.

Rate of Return on Capacitor Investment

The rate of return on the capacitor investment varies, depending upon the initial load power factor and the nature of the rate clause. However, it is common for capacitors to pay for themselves in one-half to two years, or an annual rate of return of 200 to 50 percent.

In one case where a plant had a low initial power factor, an annual rate of return on the capacitor investment was 800 percent. In another case, having an *initial* power factor of 94 percent, which is generally considered excellent, the average monthly power factor was improved to 100 percent, resulting in an annual rate of 50 percent.

The following are a few actual case histories of small industrial plants.

Example (1)

Average original power factor 65.3 percent.

Average demand 78 kw.

Average "billing" demand 102 kw.

Annual power bill $4,594.

Power factor improved to 94 percent.

Capacitor investment $540. (approximate *installed* cost of 60 kvar. of 460-volt capacitors)

Annual saving $537.

Annual gross rate of return *99 percent.*

This rate clause had a "billing" demand adjustment for power factor with an energy clause independent of kilowatt demand.

Example (2)

Average original power factor 70.3 percent.

Average demand 51 kw.

Average "billing" demand 62 kw.

Annual power bill $1,483.

Power factor improved to approximately 92 percent.

Capacitor investment $275.

(Approximate *installed* cost of 30 kvar. of 460-volt capacitors.)

Annual saving $306.

Annual gross rate of return *111 percent.*

This rate clause had a "billing" demand plus an energy rate dependent upon the billing demand.

Types of Power Factor Clauses Attractive for Power Factor Improvement

The basic types of rate structures attractive for reduction in power costs by power factor improvement are:

(a) Kilowatt demand charge based on so called "billing" or "contract" demand is dependent upon the ratio of base to actual power factor, such as

$$\text{Billing kw. Demand} = \frac{\text{Base PF} \times \text{Actual kw. Demand}}{\text{Actual PF}}$$

Base power factor is usually 80–85 percent, so whenever the actual power factor is less than the base power factor the billing demand is increased.

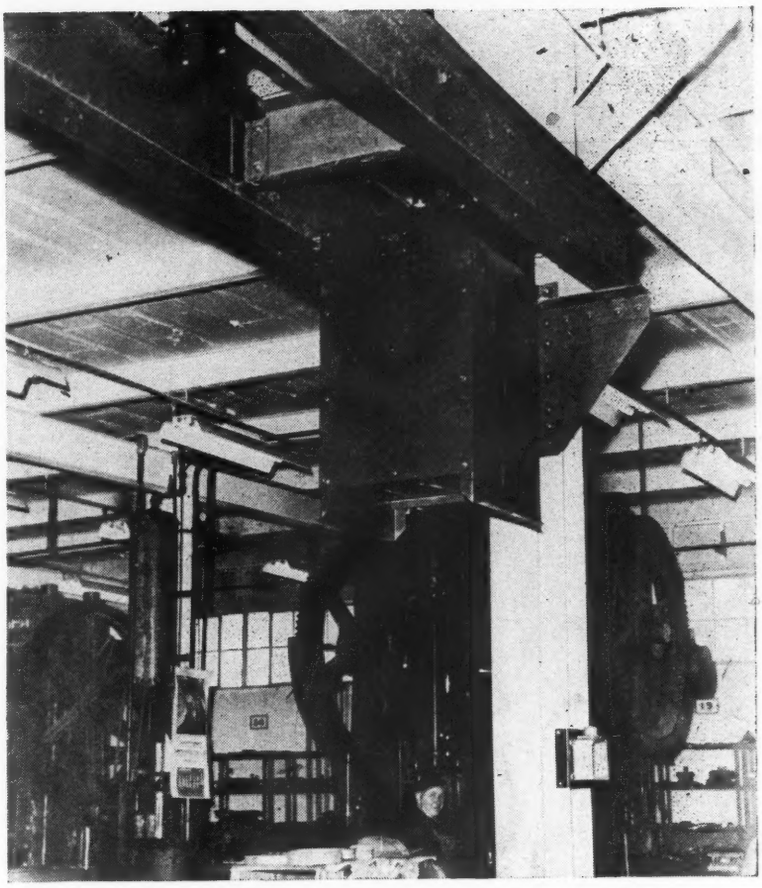
(b) Same as (a) with a billing kilowatt demand charge plus an energy charge dependent upon *billing* demand.

With this type of rate structure, improvement in power factor becomes very attractive since both the demand and energy charges are reduced.

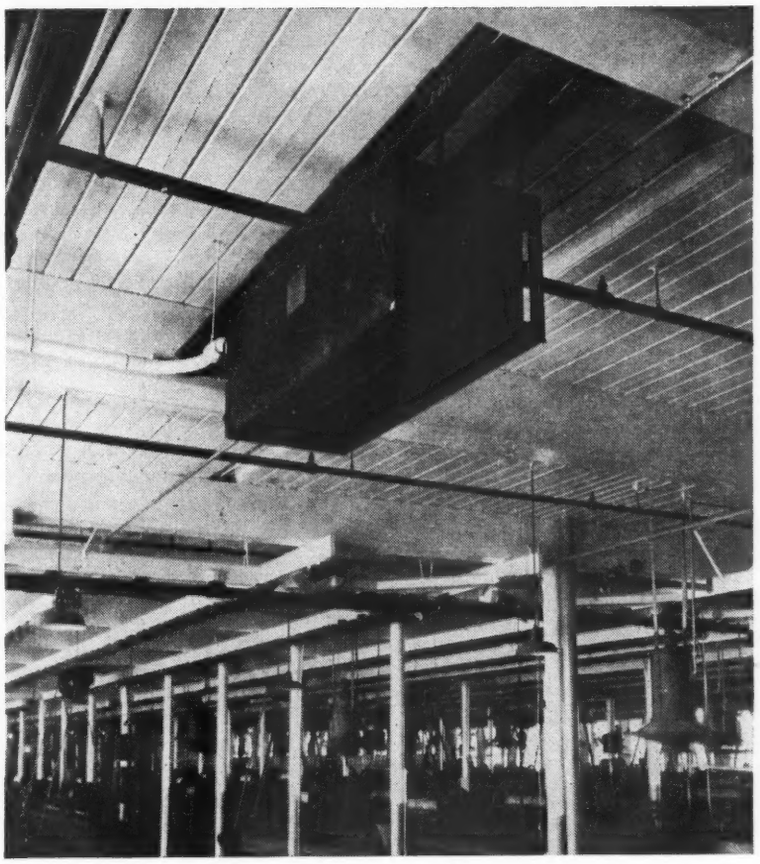
(c) Billing demand based on *actual kva.* with energy charges dependent or independent of billing demand.

(d) Flat percentage increase or decrease to power bill depending upon the amount the average power factor is less or more than the base power factor.

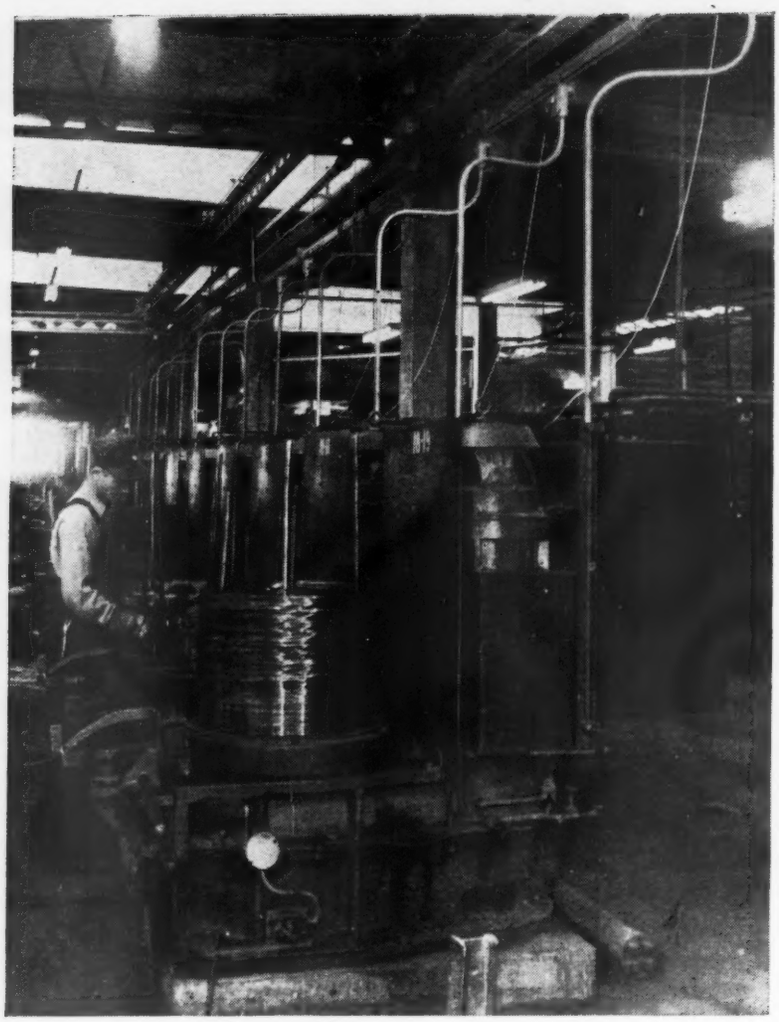
(e) Independent charges for kilowatt and/or kilovar demands. A modification of this is the two rate structure, one for kw-hours and another for kvar.-hours.



Small rack capacitor equipment for power factor improvement in a machinery manufacturing plant.



Ceiling-mounted type small rack capacitor equipment rated 120 kvar., for power factor improvement in a yarn spinning mill.



15-kvar, 460 volt capacitor for power factor improvement of an induction motor in a wire mill.

An examination of several hundred power rate schedules showed that:

(1) Approximately 67 percent contained an adjustment on the demand only, the so-called billing demand, and 22 percent an adjustment on energy only, and the remainder on demand and energy.

(2) The most common base power factors were 80 to 85 per cent (approximately $\frac{2}{3}$ of the schedules) but the range was from 70 to 95 percent.

(3) The number of schedules providing for an adjustment above or below a base power factor was almost as great as the number providing for a penalty for low power factor.

(4) Power factor provisions in rate schedules are most common for services classified as "Industrial and Large Power" but are also used to a large extent for "General Power", and "Light and Power". Power factor clauses are seldom incorporated in "General and Commercial Service".

(5) Billing adjustments for power factor made by adjusting the units of demand or energy or both were twice as common as a direct monetary adjustment of the power bill.

How Far Can the Power Factor be Improved?

The amount of power factor improvement depends upon the original power factor and the type of rate structure, so each case should be studied individually. However, it is generally economical to improve the power factor to take advantage of the full amount of the penalty and bonus. A rough rule that has been used and is generally recommended is to improve the power factor to a value of from 90 to 95 percent.

What Size Plant Can Justify Capacitors

Practically every size of plant having the usual type of power factor rate structure can justify capacitors. It is the *rate of return* on the capacitor investment which is the important factor. Actually, the rate of return will probably be greater for small plants because of the higher demand and energy charges for small loads. Examples (1) and (2) show the attractive rate of return for small plants.

Records show that the most popular capacitor ratings are 90 and 120 kvar. These kilovar ratings correspond to plants having substation ratings in the order of 250 to 500 kva.

Utilities Help Encourage Customers to Improve Load Power Factor

Many utilities are actively encouraging their industrial customers to improve their load power factor. In the past, some utilities did not enforce their power factor clauses, but now they are beginning to do so because of the difficulty in obtaining additional equipment and the necessity to reduce capital investment per kilowatt of installed capacity.

In some cases, utility power salesmen periodically review power bills with their customers and show them how much they can save by power factor improvement. This is a sound and progressive policy, since lower power costs encourage greater use of electricity.

Some utilities encourage their customers to improve power factor of certain types of low power factor loads; for example, oil field pumping service where the average power factor is rarely better than 65 percent. Power factor improvement will often provide added capacity needed for small loads, such as the addition of new lighting units to a part of the plant.

Code problems were discussed by J. D. Lynett, superintendent, Bureau of Fire Underwriters, New York and Dave Davidson, Davidson Electric Company, Brooklyn, during the meeting of the New York State Association of Electrical Contractors & Dealers, Inc. at Saranac Inn.

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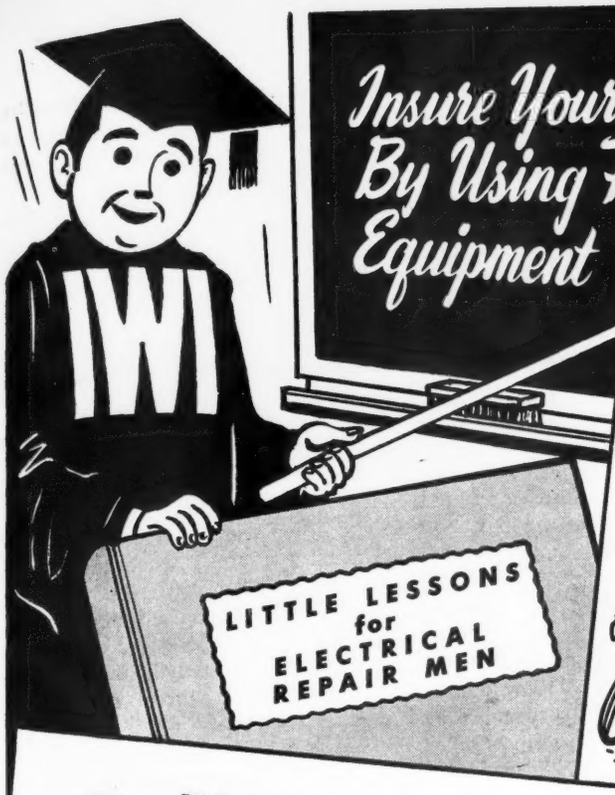

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Reader's Quiz

Rewinding Coils

QUESTION 258—We have received at our plant many 440 volt a-c contactors and a few 110-volt a-c contactors from surplus. As our main using voltage is 230 volt three phase, we cannot use these contactors without rewinding the holding coils. Can anyone give us a simple formula, as to changing size of wire and number of turns, for rewinding coils for 230 volt a-c accurately? We do not want to use transformers to operate these coils. —L.R.D.

A. TO QUESTION 258—We have overcome the same problem in the following manner:—We must keep in mind that the magnetic strength of the coils must remain the same at 220 volts; we take the tape covering off the 440 v. coils, measure the distance in ohms across the terminals, locate if possible the center of the winding with the ohmmeter test prongs, where the resistance between that point and any one of the terminals is as close as possible to one half the total resistance of the coil; sometimes two or three trials are necessary before the ohmic center is found. After the center is found, the wire is broken and the ends lengthened to reach to each corresponding terminal. By this operation, two approximately balanced circuits are established inside the coil and approximately the same magnetic strength of the coil is retained. After this operation is completed, the coil is retaped, dipped in baking varnish and baked.

Rewinding a 220 volt coil to replace a 440 volt coil, the following operations take place. We take the tape covering off the 440 volt coil and take all the measurements necessary and make a wooden form in which to mount the coil and at the same time will serve to rewind the new coil. The turns of the 440 volt coil are counted and the wire used is measured (cross sectional area with wire gage). Then for the 220 v. coil we use half the number of turns as for the 440 v. coil and use a size wire which is twice the cross sectional area in mils. That is, if a 440 v. coil has 3,000 turns of No. 33 (50.41 Circular mils) AWG magnet wire, for 220 v. operation, the turns must be 1,500 and the size wire will be No. 30 (100.0 Cir. mils) magnet wire.

The holding coils for 110 volt must be rewound because they would have to be connected in series with another coil of equal impedance in order to operate at 220 volts. This condition as is readily seen, is impractical. The procedure which takes place in rewinding a 110 v. coil for 220 v. operation is the reversal of the 440 v. to 220 v. procedure. The number of turns of the 110 v. coil must be counted and the wire measured for cross-sectional area. The 220 volt coil must have twice the number of turns as the 110 v. coil and the wire must be one half the cross-sectional area; that is, if the 110 v. coil has 750 turns of No. 27 (201.6 Circular mils) AWG magnet wire, the 220 v. coil must have 1,500 turns of No. 30 (100.0 Cir. mils) magnet wire. By this method, no mathematical computations are necessary and all operations can be performed by the practical electrician.—E.D.A.

A. TO QUESTION 258—The usual formulas for electromagnets take into consideration the physical characteristics of the magnetic circuit. Since these are not changed when substituting coils of different ratings, they may be neglected.

For clapper type magnets having ample core cross-section, as are usually found in magnetic starters, rewinding formula may be stated:

The magnetic pull is proportional to the square of the voltage, divided by the square of the number of turns.

In other words, a 220 volt magnet-coil has only one-fourth the turns of a 440 volt coil, for the same duty. Similarly, a 220 volt coil has four times the turns of a 110 volt coil.

The coils should be rewound so that their physical proportions are approximately unchanged. The rule in this case may be stated:

The cross-section of the wire is inversely proportional to the voltage.

In other words, wire size must be doubled (in area) when rewinding a 440 volt coil for 220 volts. Similarly, the area must be halved when rewinding a 110 volt coil for 220 volts. Wire size may be chosen by applying the rule that increasing three sizes AWG doubles the area.

The rules given neglect refinements of ratio of resistance to reactance, space factor, and certain components of solenoid pull. However, they give a guide for preliminary estimating.

It is suggested that a pilot coil be made, having nearly the same physical dimensions as the original. The number of turns may not be the same as calculated if there are limitations on winding space. After winding, it should be checked under working conditions to see that the contactor is moved properly. Also, it should be left on the line for several hours to see that it does not overheat. If the coil will not move the contactor and overheating occurs, the number of turns should be increased.

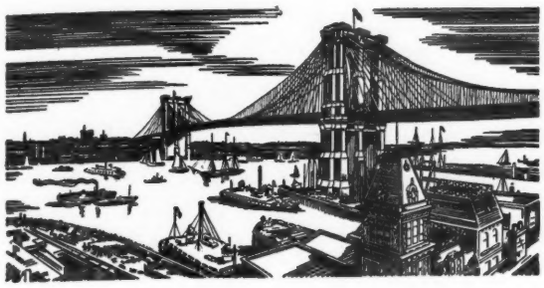
Preliminary information required from the old coil is wire size, number of turns, length and diameter of entire winding.

Since design is largely a cut and try proposition, final specifications are often adjusted by experience.—L.E.B.

A. TO QUESTION 258—To rewind a starter coil for different voltage, two conditions must be met: 1) Change the number of turns in direct ratio to the voltage change, and 2) Change the wire size in inverse ratio to the voltage change.

Thus, to rewind a 440 volt coil for 230 volt operation, the number of turns on the new coil will be equal to the turns of the original coil multiplied by 230/440. In all probability, operation will be entirely satisfactory if the number of turns is cut exactly in half. To determine the new wire size, find by micrometer and reference to a magnet wire table the circular

. . . how much is it worth?



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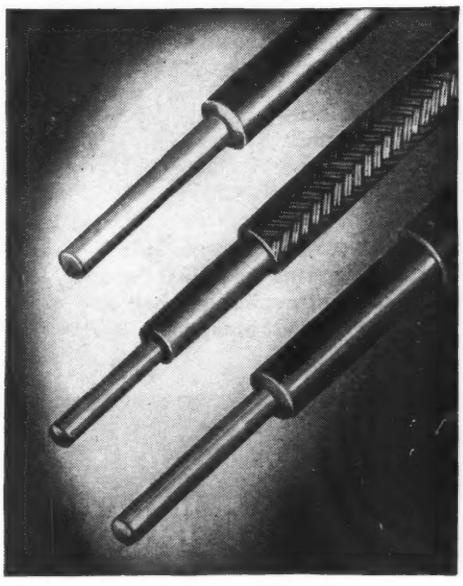

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mil area of the old wire, multiply this figure by 440/230, and select from the table the size wire having nearest to this area. This procedure can be simplified by remembering that the area of the wire approximately doubles for each 3 gauge numbers. Thus, for example, if the wire in the original 440 volt coil is No. 24, No. 21 will be correct for the 230 volt coil.

From a practical point of view, the manufacturers of the contactors can probably supply you with 230 volt coils at a considerably lower cost than winding them yourself.—W.B.S.

A. TO QUESTION 258 — I would like to suggest a solution that should be much more practical than rewinding to the new voltage.

Most types of contactors are manufactured so that coils of various voltages may be used on the one contactor, e.g., a 440 volt coil could be replaced by the manufacturer's coil for 220 volts for the same switch. Recently, while converting a factory's electrical equipment from 440 v. to 220 v. upon moving to a local plant this solution worked for almost 95% of the contactors and magnetic coils for other uses. Although this does not directly answer L.R.D. as to rewinding the coils, I believe this is a much more practical approach to the problem.—W.R.S.

Bus Duct System

Q *UESTION 259—We are rebuilding our feeder system (3 phase, 220 v.) and installing a system of bus duct of 2000 amp. capacity. We are not able to obtain copper bus for the bus in the switch cabinet, but we can obtain aluminum bus.*

We are not sure if the connection of copper bus to aluminum bus would be practical, or permissible. If practical, what type of connection should be used?—D.R.M.

A. TO QUESTION 259—It is a well known fact that when two dissimilar metals are placed together, an electric current will be generated—if there is a closed circuit. To avoid possible troubles, it has been the general practice not to have such a contact if practicable.

Violations of the accepted theories can be found by the scores. For instance, silver contacts on a bronze relay leaf which is in turn connected to a copper pigtail; tin coating on copper wire; soldering or brazing joints in

1 1561—Crude, manually-operated bellows were used in an attempt to pump fresh air into a mine, but with indifferent results, according to a journal published in Switzerland. And man's quest for comfort indoors was under way.

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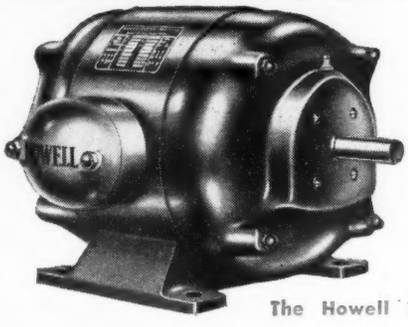

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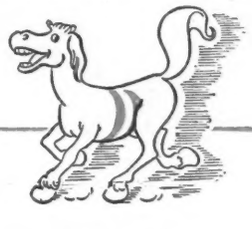

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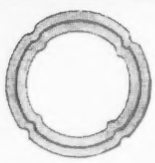

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copper wire; iron, bronze or aluminum clamps on a copper bus. Recently, a leading manufacturer has introduced a line of aluminum building wire which, with the use of proper solders and fluxes, can be used with copper wiring —splices and all other considerations.

These contacts of dissimilar metals are possible under operating conditions because there is no electrolyte or other means of completing the circuit from one metal to the other and back to the first. Observation and tests indicate that possible faults are negligible under normal conditions.

The use of bolted or clamped connections between copper and aluminum busbars is practical. The small differences in expansion coefficients may be neglected at the joints. Use of copper and aluminum combinations has been sanctioned, and is permissible.

There are two important factors to be considered. First, the aluminum bus must have a 61 percent greater cross section than the copper bus for the same resistance per foot. With the greater cross section, the aluminum bus will have only 49 percent of the weight and 64 percent of the mechanical strength of the copper. The second consideration requires that there be little or no chance of a condensation across the copper-aluminum joint which will form an electrolyte.—L.E.B.

A. TO QUESTION 259—When joining bus bars of aluminum to those of copper, care is necessary to avoid galvanic action. The recommended practice to follow, and that which experience has proved effective, is a completely clean surface, exclusion of any electrolyte and sufficient pressure. Bus joints most commonly used are the bolted or clamped type. The contact resistance of the joint is dependent upon the contact pressure and the condition of the contact surfaces. In general, the greater the pressure between the contact surfaces, the less will be the contact resistance.

For a given bus bar joint, the largest size bolt consistent with other necessary considerations should be chosen.

Bus bar surfaces to be cleaned with emery cloth, and bolted without wiping. This practice excludes air from the freshly abraded surfaces and insures lower contact resistance; this is important with aluminum on which oxide film forms instantaneously.

Hard-drawn aluminum usually used for bus work has a conductivity of 60 percent as compared with copper at 99 percent. For a given current rating for equal limiting temperatures the area of aluminum bus will in general be 127 percent of the area of the copper bus. For this reason calculations regarding the copper aluminum joints

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Please ship .....(Quantity) Motor Parts Assortment M-1 ($11.25 net each) $.....
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Shipping Weight 46 pounds

Order No..... Total $.....

Company.....

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M47-21

Wagner WE Electric

should be made on the basis of aluminum.—A.J.L.

A. TO QUESTION 259—The connection of aluminum to copper bus is quite satisfactory if care is taken to insure a joint of sufficient lap and contact pressure, and exclusion of air and moisture from the contact area of the joint is reasonably well effected in making up the connection.

The code places some restriction on uses of dissimilar metals in corrosive atmospheres, however, assuming the switch cabinet to be in a dry location no trouble will be encountered in the aluminum-copper connection. To prevent establishing a galvanic couple, which is easy to do in the absence of water, is the primary consideration, and can be accomplished as follows:

The bus bar surfaces to be joined, both copper and aluminum, should be cleaned with emery cloth, wiped clean, smeared with petrolatum or other accepted special compounds, then rubbed lightly with fine emery cloth and tightly bolted without wiping.

This procedure excludes air from the joint and prevents formation of aluminum oxide, which would otherwise form almost instantaneously on the aluminum bar.—R.L.M.

A. TO QUESTION 259—The N. E. Code has provided no definite rules pertaining to the use of aluminum wire or aluminum bus duct.

In Section 3462 it states that in corrosive atmosphere the use of dissimilar metals in raceways throughout the system shall be avoided to eliminate the possibility of galvanic action. But if your switch cabinet is in a vault where the atmosphere is non-corrosive, it would be permissible to connect aluminum bus to copper bus, according to the present Code.

It could then be connected the same way you connect your copper bus. We have used some cast aluminum bolts, do not know how many are on the market at the present time.—R.D.R.

A. TO QUESTION 259—In most cases it will be bad practice to connect the aluminum and copper busses directly together. Trouble would possibly be encountered because of electrolytic action between the copper and the aluminum. In some conditions of atmosphere no trouble would be experienced, but where there is any possibility of moisture being present even from condensation, the connections should be avoided. Special galvanized clamps are available such that both the copper and the aluminum are connected to the galvanized coating and no trouble is to be expected. Although I have had no direct experience with the following two suggested

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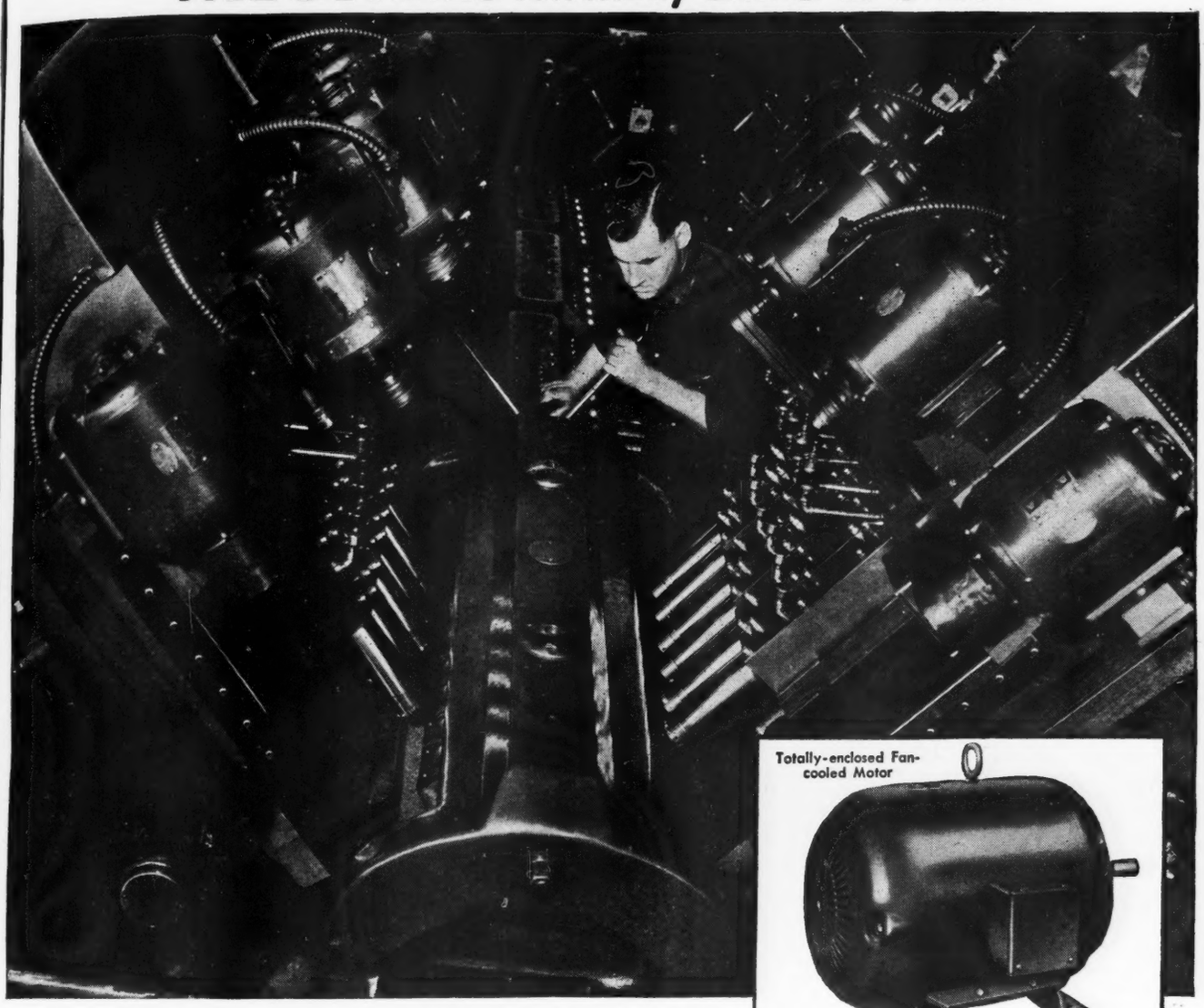

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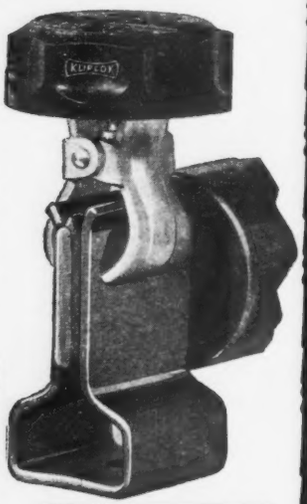

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methods, I believe either should prove satisfactory. First, use a thin zinc sheet between the copper and the aluminum busses as they are clamped together. Or, second, thoroughly tin, preferably by dipping, the ends of the copper bars, so that the aluminum will contact with solder and thus not directly contact the copper bars.—L.R.B.

Can you ANSWER these QUESTIONS?

QUESTION A12—Please explain why a single phase repulsion induction motor does not change direction? This motor has been rewound. And although we shifted the brush holder as far as possible, it still does not change direction. —F.L.

QUESTION B12—Could any reader tell me how to stop the hum in fluorescent lamp ballast transformers?—D.A.C.

QUESTION B12—What is the best practical method of finding the correct wires to put together in a delta connected 220-440 volt motor when all the original identification on the terminals are destroyed? The motor has 12 wires extending from housing and all at present are unidentified—E.Y.V.

QUESTION B12—There are quite a number of magnetic chucks used in our plant. Can any of your readers suggest a remedy to eliminate moisture that forms inside the case? We have used many kinds of compounds for sealing, in an effort to keep the inside of the magnetic chuck dry, but all to no avail. —W.H.L.

QUESTION B12—I have a ¼ hp. capacitor start motor which drives the blower on a domestic oil burning furnace. The owner complains of a dull thudding noise as this motor comes to a stop. After examination, I decided this was due to the charge held by the capacitor discharging through the windings as the starting switch closed, and tried to remedy it by soldering a 50,000 ohm. carbon resistor directly across the terminals of the capacitor to discharge it. However, as this did not improve the situation, what could cause this noise and how can it be remedied? Nearly the same sound is observed with the belt removed.—J.H.N.

PLEASE SEND IN YOUR ANSWERS BY NOVEMBER 15

Answered by
F. N. M. SQUIRES and GLENN ROWELL
New York Board of Fire Underwriters
Chief Inspector
New York, N. Y.
Electrical Engineer
Fire Underwriters Inspection Bureau
Minneapolis, Minn.

Questions on the Code

Plug Fuses On 220 Volts

Q. *Is it permissible to use a 30 amp. disconnect switch with plug fuses on an electric hot water heater 220 volts.—N.K.McA.*

A. Section 2403 Paragraph a, states in part that "Plug fuses and fuse holders shall not be used in circuits exceeding 125 volts between conductors, except circuits of a system having a grounded neutral and no conductor at more than 150 volts to ground.

This means that plug fuses may be used on a 220 volt hot water heater provided the source of supply is from a system having a grounded neutral such as a 3 wire single phase 110-220 volt system with a grounded neutral or a 3 phase 4 wire 120-208 volt Y connected systems, etc.—F.N.M.S.

Transformer Vaults

Q. *A factory building is being remodeled and they wish to install transformer vaults on every other floor and feed each vault separately from a 13,800 volt distribution system. Must there be a single disconnect on the incoming service that will disconnect the 13,800 volt service feeding each one of the transformer vaults or can we use four separate disconnects, one for each vault? Do these disconnects have to be enclosed within a vault where the service enters the building.—F.P.*

A. The Code will not require a single disconnecting switch but will permit up to six subdivisions of the incoming service. This permission will be found under Section 2351-a. These switches must be either of the metal enclosed switch gear type as described under Section 2389 or enclosed within a standard vault. Previous editions of the N. E. Code limited voltages outside of standard vaults to 7500, but the 1947 Code has increased this limitation to 15,000 volts. The metal enclosed switch gear referred to in the above mentioned section must consist of switch gear having a substantial steel structure and a steel enclosure not less than one-eighth inch in thickness over sides and top. Such enclosure must be furnished as an integral part of the switch. The disconnects should, of course be located at the point where the service enters the building. However, conductors in conduit or duct covered by not less than two inches of concrete or brick are considered as being outside the building.—G.R.

Number of Outlets On a Circuit

Q. *How many outlets can be placed on a circuit in wiring a house?—H.G.*

A. In dwelling occupancies there is no stated limit to the number of fixture outlets which may be placed on a circuit. The *load* and not the number of outlets is restricted. The load on a 15 amp. branch circuit (the one most commonly used in dwellings), is limited to 15 amp.

There is, however, a *minimum* limitation to the number of circuits which *must* be installed. This is computed from the square foot area of the building.—F.N.M.S.

Branches from Busway

Q. *We have installed a bus system in a metalworking plant and would like to drop to each machine with flexible cord instead of conduit. Will the Code permit this or must we use conduit with a short lead of greenfield at the machine?—R.R.*

A. The use of suitable cord assemblies for the connection of machines to overhead bus depends upon the intended use of the machine and local ordinances. Section 3646 of the N. E. Code states that "branches from busways shall be made with busways or with rigid conduit or flexible metal conduit, electrical metallic tubing, surface metal raceway, armored cable or, for portable appliances, with suitable cord assemblies approved for hard usage". Therefore the question of whether or not a machine is a portable appliance will have to be determined first. The Code definition of a portable appliance is as follows: "An appliance capable of being readily moved where established practice or the conditions of use make it necessary or convenient for it to be detached from its source of current by means of flexible cord and attachment plug." Many production lines on which two or more products are manufactured require the shifting or moving of certain machines from one location to another and in such instances the use of a Type S flexible cord will be suitable. On the other hand, there are many machines which may never be moved during their useful life and they should, of course, be connected to the current source by conduit, tubing, or some other approved metallic raceway.—G.R.

Fittings

Q. *May we use black enameled pull boxes on conduit runs in a paper pulp plant?—R. M.*

A. No, Section 3003 of the Code requires that ferrous fittings or boxes cannot be used where subject to severe corrosive atmosphere and in the fine print note following this section you will find that a paper pulp

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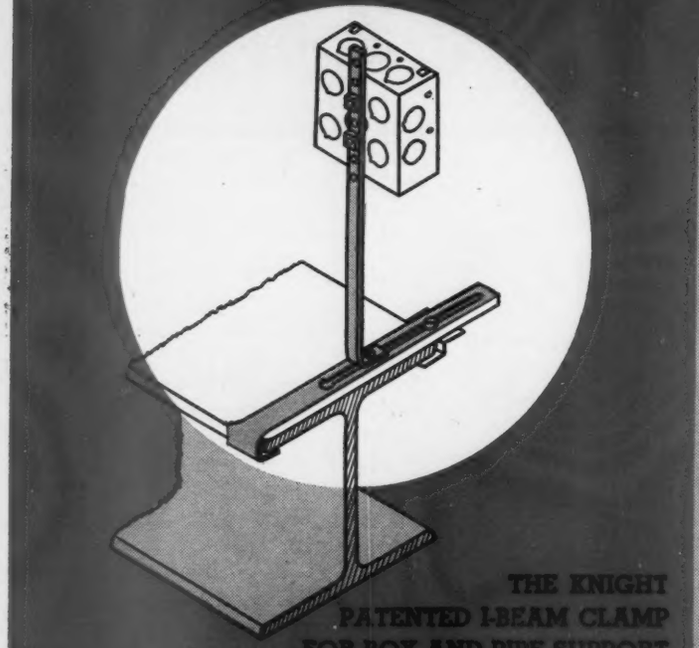

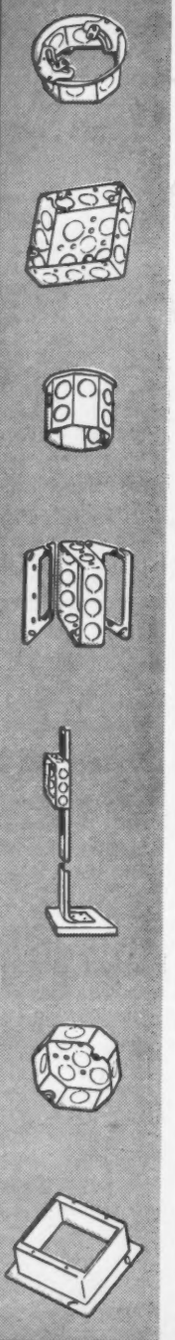

Making use of adjacent I-beams for supporting boxes and pipes has always posed a knotty problem. Weirdly contorted brackets, made by hand at large expense, were the usual solution. But the Knight Patented I-Beam Clamp has made obsolete all such makeshift contrivances. A few minutes work with a screwdriver is all that is needed to securely support a box or pipe from the nearest I-beam. The Knight Patented I-Beam Clamp is adjustable to fit flanges from 2½ to 9 inches in width, and although it makes a rigid, permanent support, it can be removed or relocated with the same ease as it was installed.

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plant is listed as one likely to contain a severely corrosive atmosphere. This same caution will also be found under Section 3462.—G.R.

Convenience Outlets

Q. *Many single family dwellings are being converted into 2, 3 or 4 family houses. Is it necessary to comply with Sections 2115 and 2116? —H.G.*

A. Yes. Such changes are of necessity, major changes. New tenants rightfully expect to have a safe electrical installation and not have to resort to the running of flexible cords around the rooms necessitated by the lack of sufficient outlets.

Sub-paragraph d of Section 2116 more or less bears this out.—F.N.M.S.

Receptacles

Q. *May ordinary receptacles be mounted in horizontal surface of a test bench or must they be mounted in a vertical manner?—Y.F.*

A. The Code apparently does not contain any specific reference to such an installation, however, under Section 4162, which pertains to the placing of receptacles in floors, you will find that ordinary receptacles may be used only in the elevated floors of show windows or other similar locations where the local code authority feels they may be free of mechanical injury, moisture or dirt. Most test benches are likely to contain at sometime or other small parts or dirt which would enter the openings of such a device so it would seem most advisable to mount them in a vertical position.—G.R.

Steel Tubing For Ground Rod

Q. *May steel tubing be used for a driven ground?—H.G.*

A. No. The Code mentions "conduit or pipe" which does not include metallic tubing. When the Code means electric metallic tubing it refers to it by name.

This tubing was not included in this case because of insufficient wall thickness and insufficient mechanical strength.—F.N.M.S.

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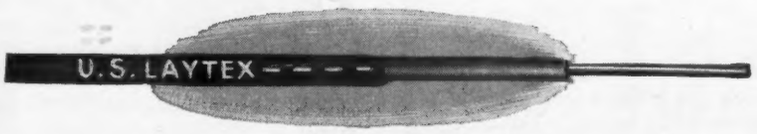

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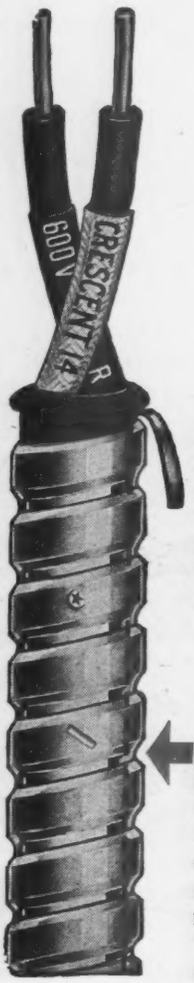

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The Cut Mark (at 1½" intervals) shows the location of a prefabricated breaking line inside the armor. Only a few strokes of a file guided by the Cut Mark are required to cut through one outer ridge, and a bend by hand severs the armor. This results in a clean separation with no sharp edge—a safer, easier and faster job. The prefabricated breaking lines are so designed that there is *no reduction* in tensile strength, bending quality, crushing resistance and electrical conductivity of armor.

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Display Lighting

Q. *The installation of lighting in display racks and cases has caused us a lot of grief. The local inspector has refused to permit the use of flexible cords supplying spots focused on certain areas of such cases. He claims the spotlights are not portable fixtures and therefore they must be connected by permanent wiring. Is this a Code ruling?—M.O.*

A. The Code under Section 4147 states that exposed flexible cord or fixture wire shall not be used to supply permanently mounted fixtures in show cases or wall cases. Therefore the spotlights you refer to might be supplied by a flexible cord if they are not permanently mounted or if the cord is not exposed.—G.R.

Number of Circuits Required

The writer has been taken to task and justly so, for the answer given to a question on this subject in the June issue.

In the issue mentioned, it was stated that a dwelling of 2100 sq. ft. of floor area could be served by one 20 amp. branch circuit for the appliances and one 15 amp. branch circuit for the lighting.

This of course was an erroneous statement as it does not comply with Section 2115. The first sentence of Section 2115a was overlooked which states that the number of circuits required for the lighting and for the appliances not supplied by the No. 12 wire circuit are to be figured on the watts per square foot area basis and this No. 12 wire circuit is not to count as one of the circuits arrived at through this computation.

The answer should have been given along these lines:
"Where a dwelling is fed by a 120 volt service, one 15 amp. branch circuit in addition to the required No. 12 wire appliance circuit could serve for lighting and receptacle outlets (other than in kitchen, pantry, dining-room and laundry) for an area of 900 sq. ft. (a house say of about 30 ft. by 30 ft.), or if the supply voltage was 110 volts, the area would be reduced to 825 sq. ft. This, of course is on the assumption that no fixed appliances such as electric water heaters or electric ranges were to be installed."—F.N.M.S.

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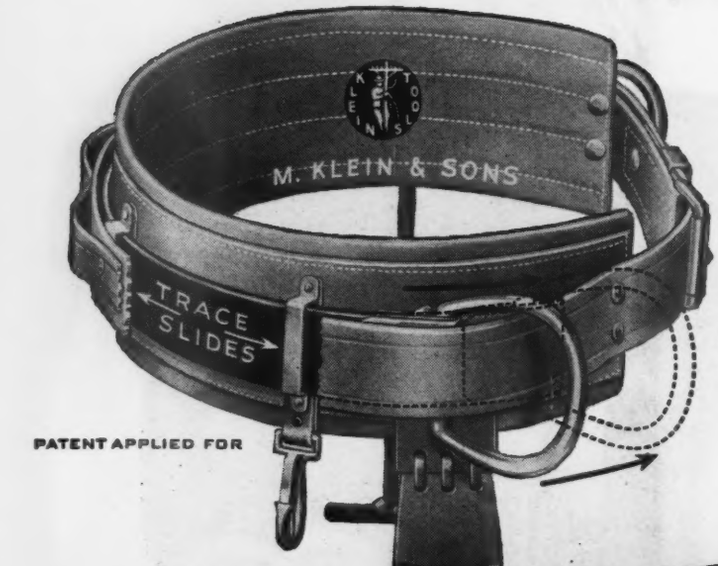

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Paint Spray Booth

Q. *Can an ordinary motor be placed within the exhaust stack of a paint spray booth if it is enclosed within a heavy sheet metal cigar shaped tube connected to outside air for cooling and to the fan blades by a shaft extending through a stuffing box? We have assembled such a unit and no paint residue has entered the motor enclosure after some seven months use, and it would be impossible for the solvent vapors to gather as the fan blades on the motor provide a flow of air through the tube.—L.W.K.*

A. While it might be possible to produce a device of this type under controlled conditions which could be given approval, the Code definitely will prohibit the assembly of such a device where definite control cannot be exercised over its manufacture. Section 4310 of the Code states that motors must be located where they can be readily maintained and obviously this might be rather difficult to comply with unless special consideration is given to the design. It would be preferable, I believe, to use the split duct method with the motor mounted in the center where it might always be accessible.—G.R.

Feeder Conductors

Q. *I am having some difficulty with a feeder in a feed mill supplying two large motors which operate an attrition mill. As I read the Code, I am limited on the fuses I can use to the value shown in the Code tables for the largest motor plus the nameplate rating of the second motor. In my case, both motors are 20 hp. three phase 220 volt motors and they usually are started at the same time. The mill operator is holding up payment of the bill for my work because whenever he attempts to start these motors at anywhere near the same time, the fuses on this feeder circuit will blow. What does the Code permit one to do in a case like this?—* H.P.H.

A. Under Section 4362 you will find a fine print note which reads as follows: "If two or more motors must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection.—G.R.

Motor Shops

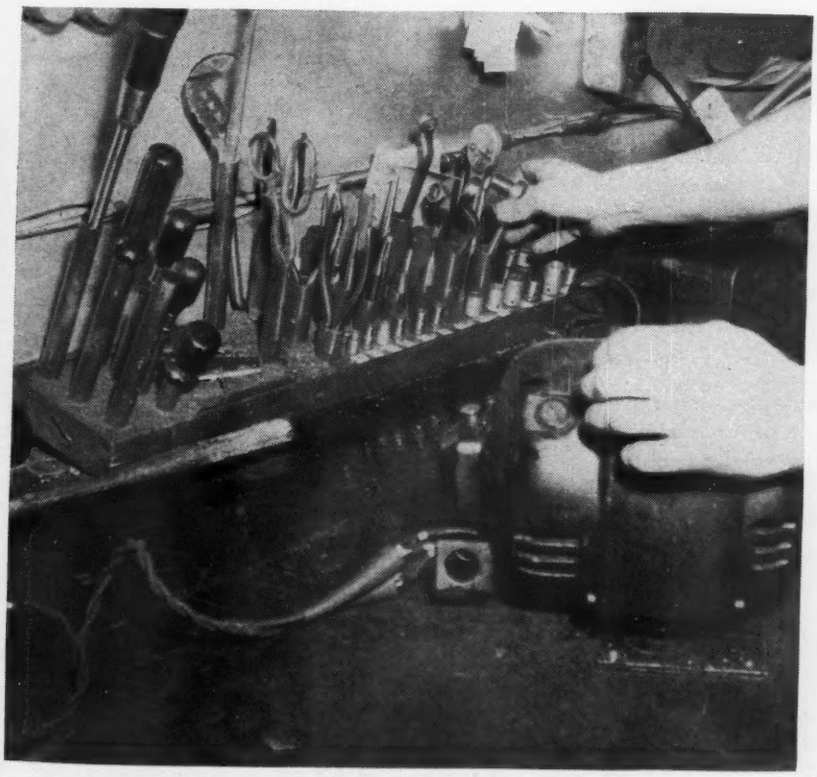
Compact Tool Rack For Work Bench

There's nothing more exasperating than to have hand tools scattered all over the work bench. They elude the eye when needed and require time-consuming unscrambling. Mechanics at the Koontz-Wagner Electric Co., South Bend, Indiana, are an orderly crew and like to have their tools where they want when they want them. So they devised a compact bench rack that not only adds to the appearance of the shop but shows up to advantage on the unit cost sheet.

Base of the rack is a section of 2-in. by 6-in. wood (length depends upon quantity of tools) with numerous holes drilled, either perpendicular or at an angle, to accommodate short sections of thin-wall tubing which hold screw drivers, pliers, metal punches, wrenches, shears and other hand tools. Socket-wrench accessories are held in place by short pins or nails.

Mounted lengthwise at the back of the bench against the partition, the rack leaves a clear working space.

Armature sub-assembly work at Jay Electric Company, Detroit motor service shop, keeps a man busy dipping units and loading bake oven. Dip tank is on casters, as is rack on which armatures rest when in the oven.



Bench rack eliminates time-consuming tool searches; keeps hand tools in order within easy reach of the mechanic.

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Heavy equipment can be lifted from delivery trucks by overhead cranes and carried, in a single operation, to all areas of the repair shop of the New England Machine and Electric Company, Pawtucket, Rhode Island. This is done entirely by electric, pushbutton operated, traveling hoists operating along a huge U-shaped overhead monorail which terminates on two separate loading platforms and which travels over the stock area and a section of the repair department. An added feature to the usual continuous run of monorail track is the provision making it possible to serve areas other than those immediately adjacent to the track. This is done through a series of electrical and mechanical interlocks and the independent movement of one entire section of the main monorail. This movable section is supported by two rolling trucks operating along parallel rails at right angles to the main monorail. These parallel rails extend the length of the repair area.

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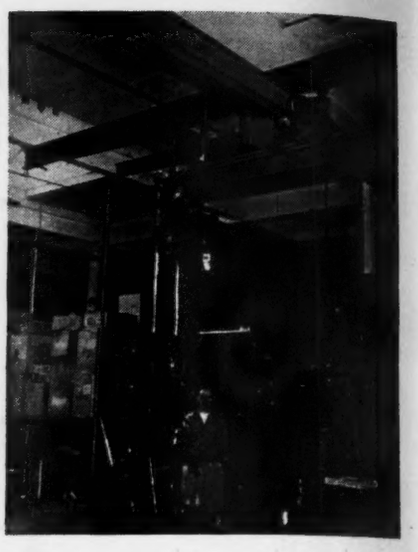

Traveling hoist is pushbutton operated and moves along U-shaped monorail system terminating at two separate loading platforms. Movable section of monorail, supported by trucks running along parallel rails at right angles to main monorail, makes it possible to carry load to any point in the repair area.

In operation, the load to be moved is raised from a delivery truck and the electric hoist rolls along the main monorail until it rests upon the movable section. This movable section is then disconnected from the main track and is carried out over the repair section. Since the hoist can still move freely along the detached monorail section, and since the detached monorail section can be carried to any location in the shop area, the combination provides complete coverage of this important area. As the hoist moves onto the movable section, mechanical dogs are tripped so that, when the movable section is removed from the main track, it is impossible for a crane to ride into the break and drop to the floor. Electrical interlocks are an added safety measure so that only that section supporting the hoist is electrified. Mechanical dogs at both ends of the detached monorail section prevent the hoist from rolling off either end while the movable section is separated from the main monorail system.

Portable Bake Tank

Flexibility is the by-word at the Dayton Electric Service Company, Dayton, Ohio motor shop. Consequently, as much as possible of their equipment is made portable. Included in this category are such items as dip tanks, degreasers, and even bake ovens.

CONDUIT FITTINGS
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ELECTRIC MOTOR MAINTENANCE

By W. W. McCULLOUGH
District Manufacturing and Repair Department, Westinghouse Electric Corporation

A book for handy reference "on the job"

Here is a book that tells in simple, direct language all you should know about the maintenance and repair of motors. It describes in fullest detail the procedures to follow in inspecting each type of motor. The author discusses the construction of each motor, the methods used to test it and the tools to be used. He also gives a full account of the cleaning and drying of motors.

Contents include: Good Maintenance and What It Means; The Mechanical Assembly of the Motor; Sleeve Bearings and Lubrication; Ball and Roller Bearings; Kingsbury Thrust Bearings; Current Collecting Devices; Air Gaps; Insulation-Materials; Insulation-Cleaning and Drying; Insulation Testing; The Induction Motor; The Direct-Current Motor; The Synchronous Motor; The Gear Motor; Motor-Generator Sets.

1947 126 Pages $2.00

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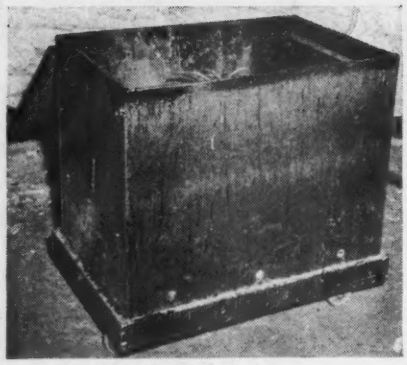
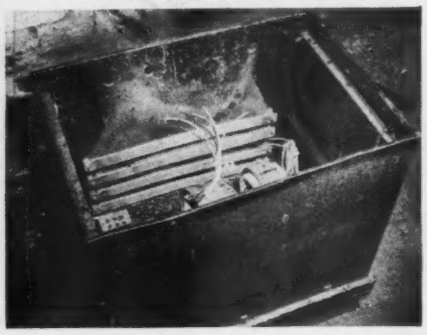


Bake tank on casters can be moved to dip tank for loading and pushed out of the way during the baking cycle.



Tank is heated by four 250 watt strip heaters. Removable tray in bottom catches excess varnish. Note vent holes.

Among such equipment is a small bake tank designed for use with small motors. It is constructed of two layers of sheet steel with a $\frac{3}{8}$-inch thick asbestos sheet between acting as insulation. The 21 in. by 30½ in. by 24 in. deep unit is mounted on four casters; has a hinged, flanged cover; is equipped with four 250 watt strip heaters connected to provide a single heat. Six 1 inch holes in the back of the tank near the cover serve as vents to prevent accumulation of gases.

Automatic thermostatic control shuts the oven off at 240°F. and turns it on again when the temperature drops to 225°F. Motors are baked between eight and nine hours. The unit is connected to a wall outlet by a long flexible cable and is controlled by the same time clock that operates the large oven. A separate time clock control could be used if desired.

Instead of moving dripping motors (just dipped) from the dip tank to the oven, Dayton Electric Service reverses this procedure and moves the oven to the dip tank for loading. The unit is then pushed out of the way while baking takes place. This portable bake tank is particularly useful when the size or number of motors to be baked do not warrant use of the larger unit. Since dipped motors are not carried across the shop, excess varnish does not accumulate on floor surfaces and these areas remain clean.

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for MOTOR REWINDING

★ 14" Inside Diameter of Ring
★ Will Take up to 5 to 7½ Hp.
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In the News

R. H. Flynn Named Publisher

Ralph H. Flynn has been appointed publisher of *Electrical Construction and Maintenance* to succeed Lee H. Hill, who has resigned as of October 1 to return to industry.

Mr. Flynn will be publisher of McGraw-Hill's electrical unit, which consists of *Electrical World* and *Electrical Wholesaling*, in addition to *Electrical Construction and Maintenance*. He became a member of *Electrical West's* editorial staff in 1930, after graduation from University of Southern California, and subsequently left to join the sales department of Pacific Gas and Electric Co. Later he became advertising manager of the then San Joaquin Power & Light Corp. Returning to *Electrical West* in 1935 as eastern manager, he was given added duties as district manager of *Electrical Merchandising* and *Electronics* in 1937. He has been assistant publisher of the unit since April 1.

RALPH H. FLYNN

IES Holds Annual Conference In New Orleans

Technical lighting developments and the Planned Lighting program were the main topics of discussion at the recent annual conference of the Illuminating Engineering Society. Over 650 members and guests, with approximately 25 members and guests from other nations, attended and participated in the week-long activities, held September 15-19, 1947, in the historic and romantic City of New Orleans.

Eight sessions, two of which were general, and six of which were technical, were held during the week. Twenty-four technical papers on various phases of lighting and related subjects were given during the six technical sessions.

The first general session was held by the Lighting Service Forum. It was an all-day session, and was devoted to a complete presentation of the Planned Lighting program. J. S. Schuchert, chairman of the Lighting Service Forum and original sponsor of the Planned Lighting program idea on an industry-wide basis, opened the session with a report on the present status of the Planned Lighting program. Other speakers then outlined what has already been done, what is currently being done, and what is planned for the future, in the way of applying the Planned Lighting program to various markets.

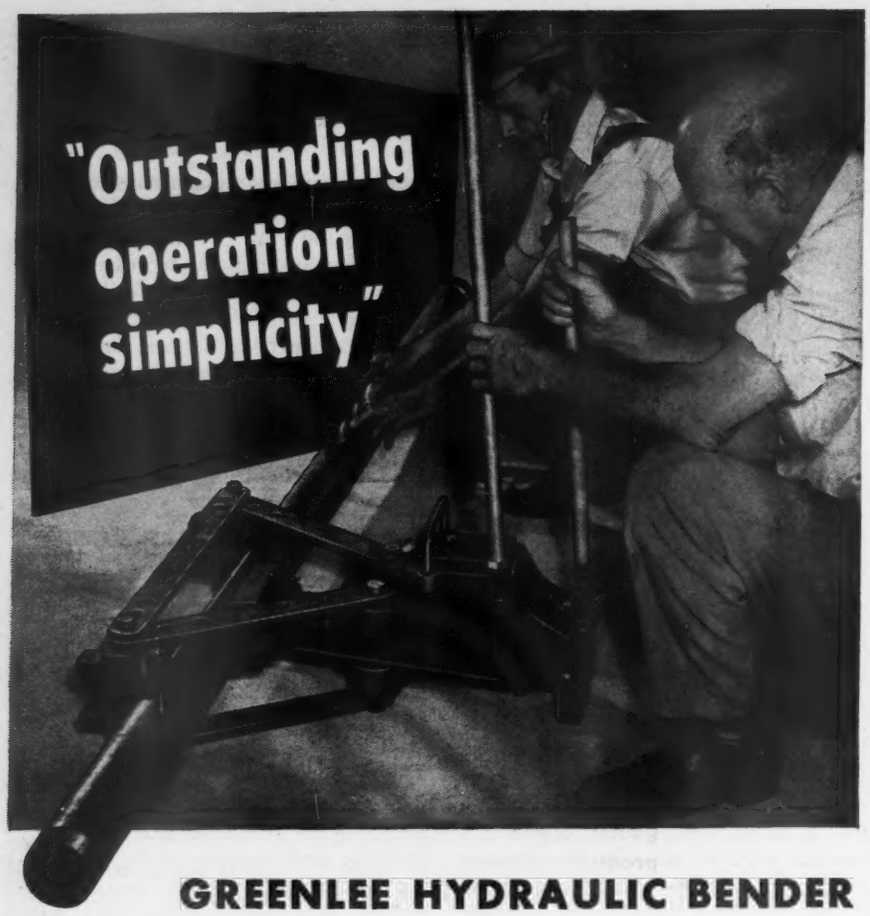
The second part of the first general session comprised a symposium on the Planned Lighting program and the lighting industry. Industry associations representing manufacturers, wholesale distributors, electrical contractors and electric utilities are solidly behind the Planned Lighting program, association representatives stressed.

The technical conference got under way with a general session, under the chairmanship of Gilbert K. Hardacre, retiring president of I.E.S. Address of welcome was made by de Lesseps S. Morrison, Mayor of New Orleans. The Society's general secretary, Walter Sturrock, General Electric Company, Nela Park, made his annual report on the activities of the Society. Mr. Hardacre then gave his President's Address, stressing the importance of the Society's work, especially at the local level. He then introduced the Society's incoming president, R. W. Staud of Benjamin Electric Manufacturing Company, who outlined the "Aims for 1947-1948".

The twenty-four technical papers which were presented covered many subjects and phases of lighting research and application. They are reviewed very briefly here. All papers will subsequently be published in full in "Illuminating Engineering", official magazine of the Society.

Two general papers were given, and opened up the technical sessions program. The first was "Illuminating Engineering as a Profession", by R. L. Biesele, Jr., professor of Electrical Engineering, Southern Methodist University. He discussed the attributes of a profession and of a professional man, and then applied those criteria to il-

"Will you plumbers get out of here! You're confusing me!"



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luminating engineering. The second general paper was "An Architect Sees Lighting", by Lawrence B. Perkins, Perkins & Wills, Architects.

E. D. Tillson, Commonwealth Edison Company, Chicago, gave the annual "Report of the Committee on Progress", in which he told of new developments in light sources and equipment.

Rene G. Maurette, Sylvania Electric Products, Inc., reported on "Ten Years of Fluorescent Fixture Development".

Four papers were devoted to various phases of research work carried out on fluorescent lamps. "Repetitive flashing of Hot Cathode Fluorescent Lamps" was presented by Fred J. Voslander of Champion Lamp Works.

"High Frequency Operation of Fluorescent Lamps" was discussed by John H. Campbell, Engineering Division of the General Electric Lamp Department at Nela Park. A paper on "Fluorescent Lamps for High Voltage Direct Current Operation" was given, by C. E. Brady, Jr., R. R. Wylie and R. G. Slauer of Sylvania Electric Products, Inc. It covered the use of fluorescent lamps on New York City subways and tests conducted in connection with this application.

"A Study of Fluorescent Lamp Maintenance" was presented by Erwin F. Lowry of Sylvania Electric Products, Inc.

Four papers were given covering various phases of street lighting, and one on outdoor lighting equipment maintenance. "Maintenance of Outdoor Lighting Equipment" was presented by Francis T. Tillemans of Westinghouse Electric Corporation. His paper covered a study made to determine light depreciation due to dirt accumulation on several typical floodlighting and street lighting installations.

As a result of tests made on Cleveland streets, Edward H. Scanlon, commission of shade trees, City of Cleveland, and Kirk M. Reid, General Electric Lamp Department, Cleveland, reported that street trees can actually increase the effectiveness of street illumination where the cones of foliage conform to the cones of light distribution from the street lamps. These and other benefits from correlation of plans were outlined in their paper "Correlation of Street Lighting and Street Tree Management".

W. H. Woods of the Toronto Hydro-Electric System, Canada, told the conference that "Municipal authorities today are showing new interest in modern street lighting techniques" in his paper "Modernizing a City Street Lighting System".

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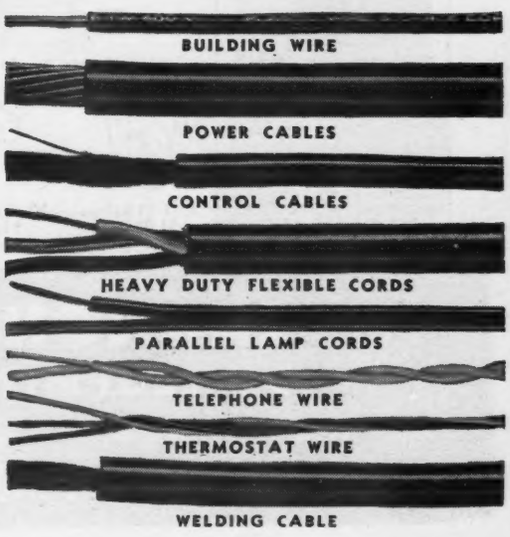

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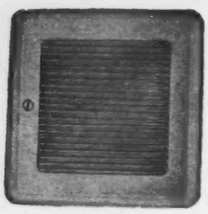
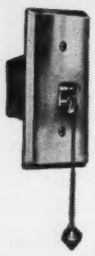


AISLE LIGHT



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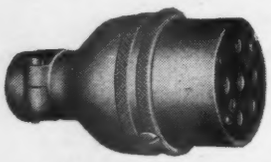
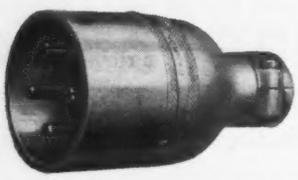
Used extensively by contractors for hospitals, public buildings and factories, Cannon Signal Systems include Silent Visual Paging Systems, Bedside Calling Stations, In-and-out Registers, Aisle, Corridor and Intersection Lights, Explosionproof Switches for Nurse's Call, Visual Station Annunciators, Supervisory Station Annunciators, Supervisory Stations, Electrostatic Grounding Intercouplers, "Knight" Lights. Other specialties include Program Bell Transfer Panels, Footrail Alarm Switches, Push Buttons, Fire Alarm Boxes. Write for the catalogs indicated below.



Type "M" POWER PLUGS 440 Volt



For heavy-duty power circuits, Type M1-4 series is listed as approved by Underwriters' Laboratories. M1-4 carries four 30-amp. contacts and is available in straight cord, angle 90° and several wall receptacle types. M2-A4 and -B4 carry 30- and 60-amp. contacts respectively. Write for Type "M" Bulletin.

Cannon Signal Systems Catalog covers the signal line of equipment and includes Architect's Typical Specifications and comparative catalog numbers. Write Dept. J-231 for a copy.

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The C-46-A Condensed Catalog contains the majority of prices and fittings and equipment manufactured by Cannon Electric. Write Dept. J-231 for a copy.

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"The Evolution of Mercury Vapor Street Lighting" was given by Dana W. Rowten, Westinghouse Electric Corporation.

"Thirty Streets in One" was the subject of the fourth paper on street lighting, and was presented by R. J. Diefenthaler and J. E. Bock, General Electric Company.

Four papers were devoted to basic fundamentals of lighting. Dr. Matthew Luckiesh, director of the Lighting Research Laboratory of the General Electric Company, discussed "Footcandle-Levels — Threshold, Recommended, Optimum and Ideal". In his talk he outlined some of the factors which in lighting practice have created enormous differences between ideal lighting levels and those which are generally found.

"Correlation of Brightness Ratios and Decorations" was the subject of a paper by W. H. Kahler, Westinghouse Electric Corporation and J. A. Meacham of the Sherwin-Williams Company.

W. E. Folsom, Dallas Power and Light Company, and R. L. Biesle, Jr., Southern Methodist University, gave a paper on "The Measurement of Illumination and Brightness in a Classroom".

"Luminaire Utilization as Affected by Candlepower Distribution" was discussed by C. E. Weitz and C. L. Amick of the General Electric Company Lamp Department, Nela Park. "You can't tell much about a lighting fixture without a candlepower distribution curve", they pointed out, and outlined methods whereby errors in choosing and installing lighting fixtures may be reduced by the correct use of candlepower distribution curves.

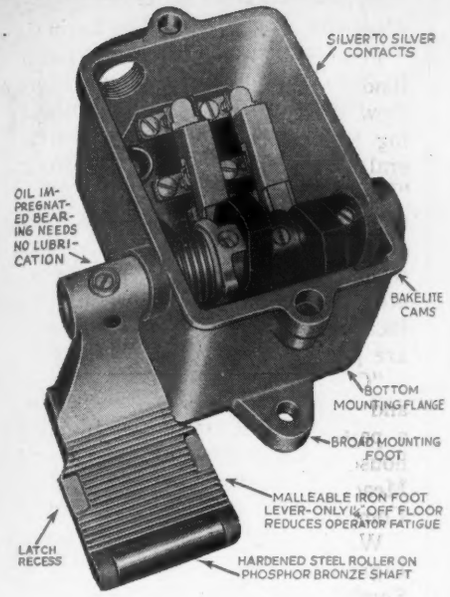
Two convention papers dealt with the subject of color in lighting. "Color Characteristics of Human Complexions" was presented by G. B. Buck, II, and H. C. Froelich of General Electric Company.

Dorothy Nickerson, color technologist with the U. S. Department of Agriculture, discussed "The Illuminant in Textile Color Matching—An Illuminant to Satisfy Preferred Conditions of Daylight-Match". This discussion represented a report of an Inter-Society Color Council subcommittee, of which the I.E.S. is one of 13 national member associations.

Five convention papers were devoted to interior lighting application. The first of these was "An Evaluation of Methods and Fixtures Used for Bathroom Mirror Lighting", and was presented by Myrtle Fahsbender and Beryle Priest, Home Lighting Department, Lamp Division, Westinghouse Electric Corporation.

"Lighting the Hospital Patient's

FOR STURDY FOOT-OPERATED PILOT CIRCUIT DEVICES
USE CLARK BULLETIN 101 FOOT SWITCHES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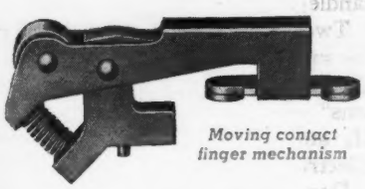

Moving contact finger mechanism

These rugged foot switches permit the operator to use his hands for other operations. In a heavy cast case, with malleable iron operating pedal, the heavy duty Bakelite cams and sturdy moving contact fingers provide long life with minimum maintenance. Each pole is easily changed from N. O. to N. C. and vice versa without disassembly.

The foot pedal is only 1¼" off the floor—the operator does not have to rock back on his heels to reach it. The pedal has a roller which, by its sliding, rotating motion, greatly reduces operator fatigue. Pedal can be changed to right or left on the one-and-two pole types, using only a screwdriver.

The same moving finger mechanism fits all types of these Foot Switches, and is interchangeable in Clark Bulletin 101 Master Switches, Bulletin 102 Cam Limit Switches, Hatchway and Track Type Limit Switches.

1 or 2 pole with latch. Horizontal Mounting

4 pole

1 or 2 pole with latch. Vertical Mounting

2 pole—sequence operation

This Foot Switch has wide application in all types of machinery operation. It can be portable, mounted on a floor plate, or permanently mounted in horizontal or vertical position.

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- Easy Assembly and Disassembly
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Room" was the subject of a paper by Willard Allphin, C. B. Stiles and Albert Zack of Sylvania Electric Products, Inc.

"Lighting of a Modern Generating Station" was given by A. A. Brainerd, of Philadelphia Electric Company.

"Application Data for Downlighting Equipment" was presented by Lorin C. Brown and Priscilla Presbrey, Lamp Division, Westinghouse Electric Corporation. Much new and fundamental data are included in this report, covering lighting equipment with relatively concentrating distribution characteristics for some types of general lighting.

Kirk M. Reid, General Electric Company, and James Michaels, Public Service Company of Northern Illinois, gave a report and dramatic demonstration on "Study of Table Tennis Lighting".

Dr. Matthew Luckiesh, scientist and author, and director of the Lighting Research Laboratory of the General Electric Company was awarded the I.E.S. Gold Medal, highest honor of the Society, during the conference.

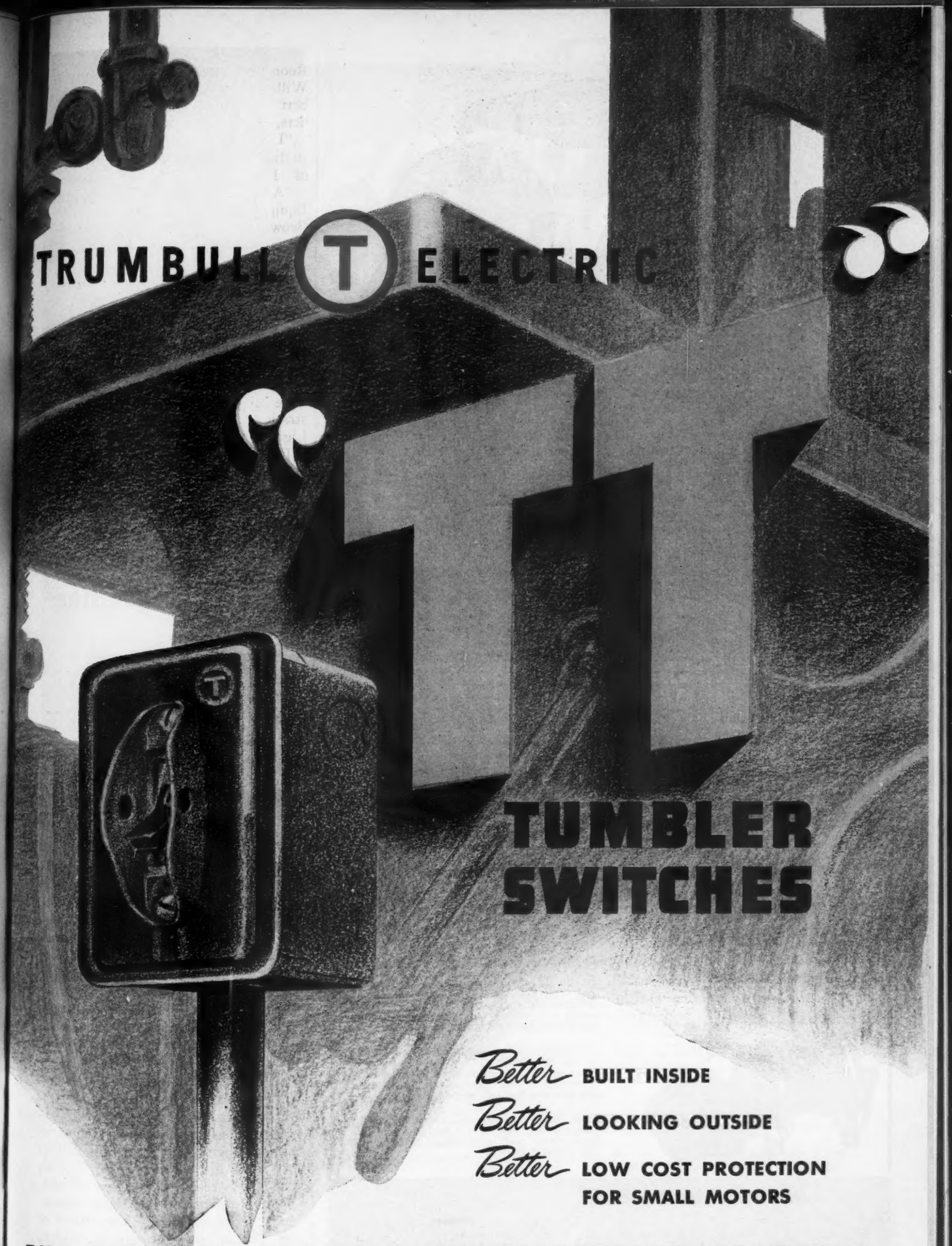
A. H. Manwaring, Philadelphia Electric and Mfg. Company, was chairman of the National Convention Committee, and in charge of the general planning. E. W. Fowler, Buffalo Niagara Electric Corporation, was chairman of the Papers Committee and organization of all technical sessions. J. Mason Guillory, New Orleans Public Service Company, Inc., was chairman of the Conference Executive Committee.

The next annual conference will be held in Boston in the early fall of 1948, it was announced.

Brown New Chairman of New York IES

Lorin C. Brown, Manager, Commercial Engineering Department, Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey, has recently been elected chairman of the New York Section, Illuminating Engineering Society for the coming fiscal year. Membership of the New York Section is over 500 members, and eight regular Section meetings are planned for the year. The Section also sponsors a Technical Forum, a Residence Lighting Forum, and will this year sponsor two educational courses in lighting.

Other Section officers are: Secretary, Berlon C. Cooper, Eastern Editor, *Electrical Construction and Maintenance*, New York, N. Y., and treasurer, Gardner M. Simes, The Simes Company, College Point, Boro-Queens, Long Island, N. Y.



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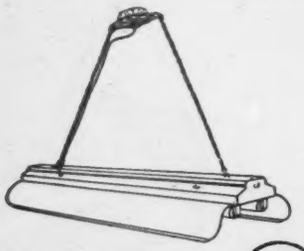
PLAINVILLE, CONNECTICUT
OTHER FACTORIES AT NORWOOD, OHIO • SAN FRANCISCO • SEATTLE • NORTH HOLLYWOOD

HANG CHAIN SUSPENSION FIXTURES IN A FEW MINUTES

WITH HYDEE HANGER*



Just connect wires—screw to outlet box. No centering, punching, drilling. No tools except a screwdriver.

Complete with receptacle, two 5-foot chains, "S" hooks and cord clips. Self-grounding—you can use 2-wire cord and plug. Fits standard 4" or 3¼" outlet box or plaster ring. $1.65 each list

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In Canada: address all inquiries to Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

*Patent No. D-141024, others pending. Underwriters approved

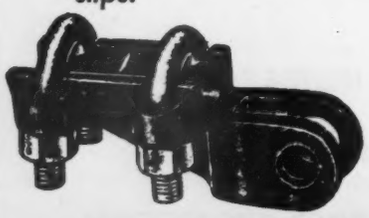
IT'S EASY TO SEE WHEN IT'S DAY-BRITE Lighting

"EFFICIENCY" DEVICES FOR CONDUIT AND CABLE SUSPENSION

Clamps available in three sizes for Cable diameters of 1/10 to 1,500,000 cm.

EFFICIENCY CABLE STRAIN-CLAMP

. . . Stands *Direct Pull* of over 17,000 lbs. before cable slips!



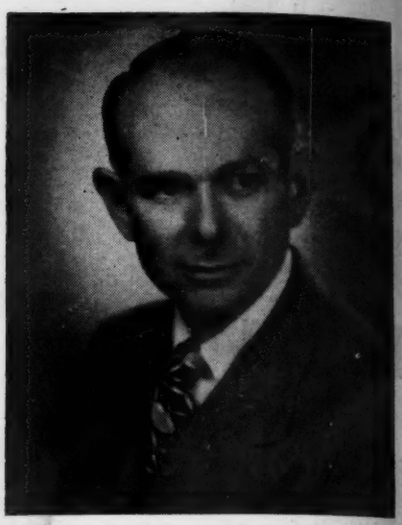
By actual test, the EFFICIENCY Cable Strain Clamp will withstand a direct pull of over 17,000 pounds without permitting the cable to slip. This powerful grip results from the EFFICIENCY Clamp's "H" design, incorporating a high ridge across the center of the cable channel and a U-bolt at each end.

Adaptability to all requirements is provided in the EFFICIENCY Clamp's alternate construction . . . which may be clevis or eye, according to your requirements. Both styles are furnished for A.C. or D.C. service.

Write today for your copy of EFFICIENCY Catalog No. 38A . . . contains complete construction and application data on all EFFICIENCY Devices.

Efficiency ELECTRIC AND MANUFACTURING CO.

MANUFACTURERS OF ELECTRICAL DEVICES FOR CONDUIT, WIRE AND CABLE SUSPENSION



B. Z. Segall has been appointed executive vice president and chief engineer of the Best Electric Co., Inc., New Orleans, La. For the past 21 years Mr. Segall has been with the New Orleans Public Service, Inc. and at the time of his resignation, he served as an electrical distribution engineer, specifically handling industrial power wiring problems.

10,000 Expected at Lighting Exposition

The greatest exposition of commercial and industrial lighting equipment ever held will reward the ten thousand lighting men, architects, industrial and commercial and school executives who plan to attend the 2nd International Lighting Exposition and Conference next Nov. 3-7, at Chicago's Stevens Hotel. So promises E. C. Huerkamp, Chairman, in announcing completion of Exposition and Conference plans and preparations.

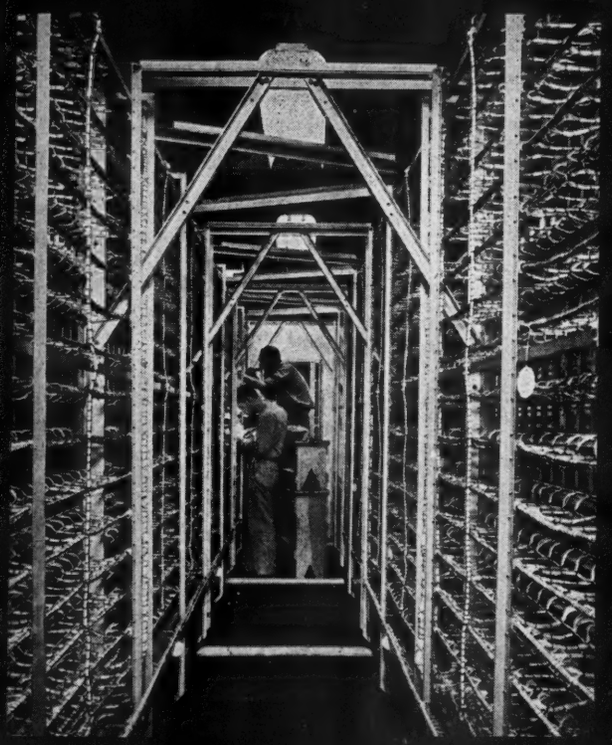
Over 80 exhibitors will answer the question, "What is new in Lighting?", with hundreds of new lighting units for factories, offices, schools, service stations, streets and highways, airports, sports fields, and other commercial applications. Many of these units will be given their first public showing at the Exposition . . . hundreds of them were only on the drawing boards eighteen months ago, when the first Exposition was held. It will provide an opportunity for all interested in lighting to see what is new in equipment.

Hundreds of photographs and layouts of the prize-winning industrial and commercial lighting installations will be on display in a special Exhibition space reserved for this purpose. These winning Merit Award installations, representing the best efforts of the leading practitioners of modern illumination among architects, electrical contractors, electrical wholesalers and utility lighting specialists,

WORLD'S LARGEST

ELECTRIC "BRAIN"

IS WIRED WITH— DELTABESTON*



A million feet of Deltabeston wire is laced into the world's largest calculator, the Navy's Mark II, at Harvard University. Deltabeston wires carry information from one "brain cell" to another, from the time a problem is set up until solutions are reached.

Answers traveling along its intricate circuits have got to be right every step of the way. That's why Deltabeston wires were selected for this job.

Why is it that Deltabeston wires and cables are so often the choice for installations that need something extra in wiring protection — where the emphasis is on doing jobs right? Above all, it's Deltabeston's well-chosen insulation — designed in a full range of styles to beat ambient heat and conductor heat for installations of all types. In addition, Deltabeston's flexibility makes it easy to handle, easy to work with on intricate jobs, without injury to insulation. And features like toughness, abrasion resistance, and moisture resistance help make it the choice for tough jobs. For unusual jobs, there are wires and cables with special features in the complete, heat-beating Deltabeston line.

Let us send you information on beating your heat problems with Deltabeston wires and cables. Write to Section Y91-1018, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

DELTABESTON

wires and cables

Silicone-treated cables ● aircraft wires
hook-up wires ● power cables
appliance wires ● fixture wires and cords
magnet wires ● locomotive cords

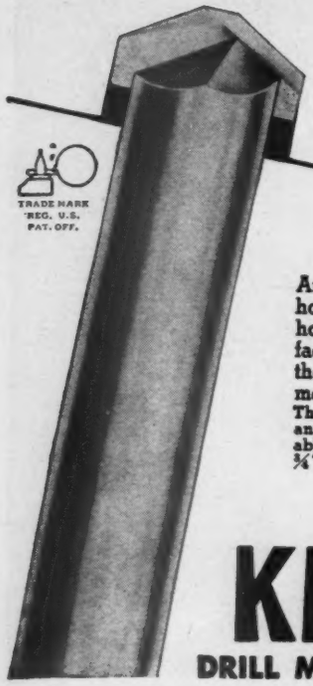
built to beat the heat

GENERAL ELECTRIC

50 HOLES

IN GLAZED TILE IN 33 MINUTES

BECAUSE THE CUTTING EDGE is KENNAMETAL



TRADE MARK REG. U.S. PAT. OFF.

An electrical contractor writes: "Kennadrills drilled 50 holes 1½" deep in glazed tile, at rate of 40 seconds per hole. Required no starting punch, and did not chip surface." Kennadrills go through masonry fast because their cutting edge is Kennametal cemented carbide—the metal that is far harder and more durable than tool steel. These new drills cut clean, don't bind, stay sharp under heat and abrasion. Can be used in any rotary electric drill. Available in following diameters: ¼", 5/16", ⅜", 7/16", ½", 9/16", ⅝", ¾", ⅞", 1", 1⅛", 1¼", and 1½".

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The Smartest 3¢ You Ever Invested!

THREE PENNIES IN POSTAGE will bring you *the* answer to *real* cost reductions in marking wires, leads, circuits, relays, parts, etc. ● As alert production, maintenance and repair men everywhere have discovered, *QUIK-LABELS* do the job better, faster and cheaper than string tags, roll tapes, decals, stencils, metal tabs, etc. ● You can't afford not to look at *QUIK-LABELS* . . . particularly when a 3c stamp will bring you FREE SAMPLES by return mail. Clip that convenient coupon now.

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Please send me FREE samples of *QUIK-LABELS*, the modern time and money saving way to mark wires, leads, circuits, relays, parts, etc.

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will be of extreme importance to all those interested in lighting. Entries have been received on practically every type of industrial and commercial lighting installation. These, together with a complete, well-balanced, star-studded conference program in which there will be afforded full discussion on the most pertinent topic in lighting, "Planned Lighting", make the conference a must to all who install, specify, buy or recommend lighting equipment, states Program Chairman W. P. Lowell, Jr.

Fluorescent Lighting Manual

The second edition of the Fuorescent Lighting Manual, first published in 1942, is now available. This manual has been completely revised, so that it now includes the latest available information on all the new types and sizes of fluorescent lamps, auxiliary equipment improvements, and recent lighting techniques. New design data have been incorporated wherever possible, and sections have been added on lighting comfort.

For those who design, sell, install, service or use modern fluorescent lighting systems, this manual will prove invaluable as a reference source. It combines in one handy book full and complete information covering the principles of operation, and the design, construction, and performance characteristics of all types of fluorescent lamps. It emphasizes practical installation design and servicing procedures, shows methods of calculating illuminating requirements, and provides timely and helpful guidance for the correct maintenance and repair of fluorescent lighting equipment. It includes important data on Slimline and Circline lamps, a full explanation of the glare rating system, a complete chapter on color and color quality, a comprehensive discussion of the latest techniques and advances in fluorescent applications, and a detailed discussion of lighting economics.

All technical data which may be required on fluorescent lighting by fluorescent equipment manufacturers, electrical contractors, dealers, lighting engineers and designers, maintenance men and users, is given in this revised manual. It is written in an easy to understand style from a practical viewpoint. Its author is Charles L. Amick, Nela Park Engineering Division, Lamp Department, General Electric Company. Its size is 6½ x 9¼ inches, contains 318 pages, and is published by the McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price is $4.00.

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HIGH TENSILE STRENGTH

That's Security Friction Tape!

Security's high tensile strength comes in handy on the tougher jobs. This electrical and general purpose tape has no pin holes—does not ravel when unwound from the roll —tears straight. Highly di-electric, Security Friction Tape has a strong, rubbery adhesive that *sticks and holds.* In factory, office or home, Security can help you in dozens of ways.

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DOSSERT CONNECTORS

--for your next power distribution job specify a--

DOSSERT HERCULON

For guaranteed dependability and economy

Available for all sizes and combinations of standard size cables or wire. For further information send for our Catalog 45 which also lists other modifications of the Herculon connector.

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READING ELECTRIC COMPANY, INC.

Parts Distributors for the Manufacturer

200 William St. ***Barclay 7-6616*** **New York 8, N. Y.**

IES Lighting Handbook

A basic, authoritative and complete reference guide on all phases of lighting has just been made available by the Illuminating Engineering Society. Its wealth of technical and scientific data is based upon rigid scientific and engineering standards. It thus possesses maximum value for lighting engineers, architects, designers, contractors, electric utility personnel, plant engineers and the many others who are interested in any phase of lighting research or application.

The handbook is divided into two sections. The first section contains engineering and scientific data presented in a factual handbook style and is carefully organized and indexed for maximum utility. This section includes a reference division covering "fundamentals" of light, and an application division covering latest design and application techniques. All phases of interior and exterior lighting are covered, as well as recreational, transportation, photographic, television, projection, miniature and minuscule lamp, and miscellaneous lighting.

The second section is devoted to manufacturers' data on lighting equipment, presented from a scientific and engineering standpoint rather than in the usual typical catalog style. It is authoritative and factual data designed to be of use to those who plan lighting installations.

The Handbook is attractively bound in a semi-flexible fine leather grain blue fabrikoid binding, stamped in gold. It is a convenient manual size, 6 x 9 inches, contains 850 pages, and is available direct from the Illuminating Engineering Society, 51 Madison Avenue, New York, 10, N. Y. Price is $7.50.

Westinghouse Lighting Handbook

A new, 260-page revised edition of the Westinghouse Lighting Handbook has been announced recently. In preparation for more than a year, it expands upon and brings up to date the previous edition published in 1943.

An authoritative reference work for anyone associated with engineered lighting installations, it contains a variety of technical data designed to aid illuminating engineers, utility lighting specialists, architects, electrical contractors, lighting fixture salesmen, consulting engineers and others.

Of particular interest is a newly-

PIPE WRENCH ECONOMY *plus easy work*

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
COPR. 1937
THE RIDGE TOOL CO.
ELYRIA, O.
TRADE RIDGID

Only RIDGID pipe wrenches give you these 5 valuable features

1) Housing guaranteed against breakage or distortion — no repair expense, ever; 2) Adjusting nut in open housing spins freely in all sizes; 3) Handy pipe scale on hookjaw; 4) Instant-action non-slip non-lock jaws; 5) Powerful comfort-grip I-beam handle. All this adds up to fast, easy work and real pipe wrench economy, too. RIDGID heavy-duty pipe wrenches, sizes from 6" to 60," are available at your Supply House.

RIDGID strap wrench won't mar polished pipe or tubing.

PIPE REAMING NOW MADE *fast, safe, easy*

The RIDGID extra-long-taper does the trick—saves you time, muscle, conduit

● You ream pipe or conduit fast and easily with this extra efficient long-taper RIDGID reamer. Long-taper prevents thinning, flaring or splitting pipe or conduit. Even on hurried work you whisk out burr cleanly with a few light ratchet strokes, leaving pipe clean and unmarred. Comes complete with ratchet handle—or will fit your RIDGID No. 00R threader handle. Save pipe, time and work. Buy it at your Supply House.

Reamer unit alone may be bought for your RIDGID No. 00R threader handle.

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WORK-SAVER PIPE TOOLS

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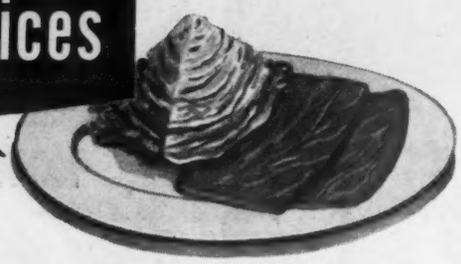
famous splices



CORNED BEEF and CABBAGE... What a combination! Everlasting as a SUPER-STIK splice. Distributed only by authorized electrical wholesalers.

Super-stik
FRICTION TAPE
"Sticks to the End"
SUPERIOR INSULATING TAPE COMPANY
ST. LOUIS, MO., U. S. A.
Established 1923

developed precalculated footcandle table which covers seven pages. By using this table, lighting men can predict easily and accurately the results to be attained by most any type of interior lighting installation with a minimum of mathematics.

Its size and make-up have been designed for maximum ease in use. Its page size is $4\frac{1}{4} \times 7\frac{3}{8}$ inches. Each chapter is numbered separately, and a "quick find" index in the form of labelled tabs is provided. The four-page subject index lists references by chapter and page. Its binding is a substantial flexible leatherette cover with a wire binder, which permits it to be laid out flat on a desk or table.

This new Lighting Handbook is available at $2.00 from the Advertising and Sales Promotion Department, Westinghouse Lamp Division, Bloomfield, New Jersey.

Residential Lighting

A 280-page authoritative reference book on residential lighting, the most comprehensive of its kind, has just come off the press and is now available. Its author is Myrtle Fahsbender, director of home lighting for the Westinghouse Electric Corporation.

This non-technical volume contains answers for every conceivable question occurring to persons interested in any phase of home lighting, ranging from how to modernize an old lamp to the effect of fluorescent light upon colors, skins, foods and wood. It was in preparation for four years, and includes 569 diagrams, sketches and photographs, and 23 tables. It is printed on $8\frac{1}{2}$ by 11 inch page size and is attractively bound.

A variety of subjects are discussed in its 13 chapters including specific recommendations for lighting each room in the house. Fixtures and shades, influence of period styling on lighting fixture design, home wiring, light and vision, color and light in the home, and suggestions on special lighting, such as garden lighting and Christmas lighting, are some of the other subjects covered.

Much progress has been made in home lighting techniques in recent years, including the introduction of fluorescent lighting, and the design of a new line of portable lamps, to be produced by the Certified Lamp Makers (CLM) which make their debut this fall. This new book on home lighting incorporates these and all other latest developments.

Miss Fahsbender is well qualified to discuss residential lighting. She is chairman of the Residence Lighting

Here's a Built-In "Extra" with Plenty of Sales Appeal!

FLUSH WALL RADIO FEATURES:
1. 5-tube AC-DC Superheterodyne Licensed by RCA and Hazeltine
2. Easy Installation—Comes with Steel Box, 6½" x 9⅝" x 3⅞" deep, which Goes Between Studding. As Easy to Install as an Electrical Receptacle Outlet
3. Easy to Service—Chassis Swings Out on Patented Adjustable Slotted Hinges
4. Attractive Instrument Panel, 7 13/16" x 11 7/16". Catalin Plastic Panels Available in Wide Choice of Colors to Harmonize with Room Decoration
5. Approved by Underwriters' Laboratories for Built-in Installation
6. Nationally Advertised in House Beautiful

Homeowners are enthusiastic about the Flush Wall Radio for two reasons. First, it enables them to enjoy the convenience of having several fine quality radios throughout the house — in kitchen, bathroom, bedrooms, study, recreation room — in addition to their large conventional living room radio. Second, it enhances the home with the custom quality look that goes with built-in equipment.

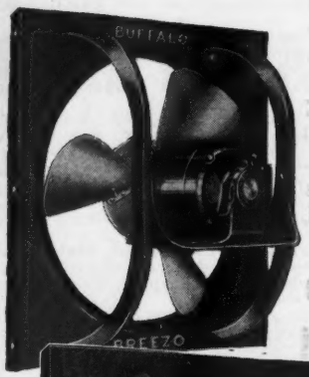
Retail Price, Model 5P Radio, $34.95
Panels Extra, From $2.45 to $4.45

ELECTRICAL CONTRACTORS AND DEALERS! Get your share of the plus profits from Flush Wall Radio sales. Write today for complete information, prices, etc. to FLUSH WALL RADIO CO., 58 E. Park St., Newark, N. J.

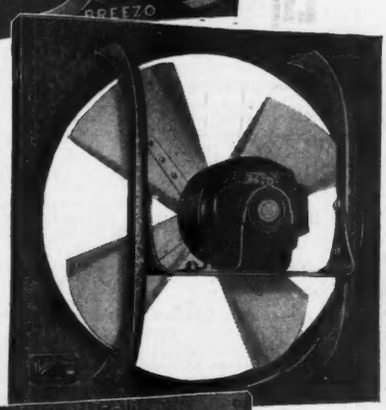
FLUSH WALL RADIO

TODAY'S STREAMLINED RADIO FOR TODAY'S STREAMLINED HOME

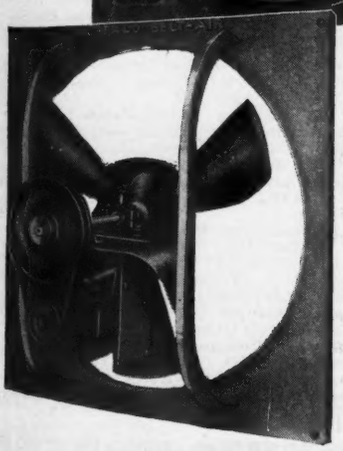
These Fans were made for HEAVY DUTY SERVICE



"Buffalo" PANEL "BREEZO" FAN



"Buffalo" TYPE "NV" Heavy-Duty Breezo Fan



"Buffalo" BELT-AIR FAN

● "EASY TO SELL, EASY TO INSTALL, EASY TO SERVICE" is the reputation "Buffalo" Disk fans have earned in the trade—and you can add consumer reports that they really deliver the air! The "Breezo" at left has square mounting panel for quick installation—proper curvature of fan opening that leaves streamlined air path, cuts air noises—all-welded steel motor brackets that give rigid, vibrationless performance — blade angles proportioned to deliver more air at less noise and cost—standard, totally enclosed motor for continuous operation.

"Buffalo" Type "NV" FANS—for heavy-duty industrial or commercial service! In 7 sizes, from 12" to 36" they can give you from 538 to 16,250 cfm free air delivery as wall-mounted fans—or 295 to 15,000 cfm at ¼" s.p. discharging into ducts! Sturdy square panel mounting, perfectly balanced die-stamped blades, this customer-proven fan at left uses standard motors from 1/20 to 3 h.p.

At left, where you need larger capacity free air delivery, "Buffalo" Belt-Air Fans are in five sizes (24" to 48") for 4,400 up to 19,000 cfm. Blades are the high-efficiency die-stamped Breezo type—and square panel mounting has sturdy motor bracket. Easy to install, economical to operate, husky enough for many years of heavy-duty service, with very little attention.

WRITE for full engineering data on this popular, proven line. **Bulletin 3222-D**

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520 Broadway **Buffalo, N. Y.**

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

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DISK FANS for Reliable Service

Best Buy

FOR BIG USERS ... the BIG 10-ROLL CAN of GOLD SEAL TAPE

● Off the market during the war, this handy 5 pound can of Gold Seal Tape is back again . . . the best buy for regular users. Every roll is doubly protected for factory freshness.

Whatever way you buy tape, you'll find Gold Seal always just right in "tack"; clean handling; non-raveling; non-peeling. Try it. Jenkins Bros. (Rubber Div.) 80 White Street, New York 13.

Jenkins Bros. also make Diamond Seal Friction and Rubber Tapes which meet ASTM and Federal Specifications.

JENKINS Gold Seal Tape FRICTION-RUBBER

MADE BY JENKINS BROS. ... MAKERS OF FAMOUS JENKINS VALVES

CONTRACTOR SAYS...

"Each Borer Paid For Itself In Less Than 90 Days!"

Typical report from an enthusiastic user of the KETT Tall Reach Wood Borer are statements in a letter from Mr. F. Haeussler, president of the Boothby Heating Co.*

"Saving more than 75% of the time ordinarily used . . . crews equipped with KETT Wood Borers were able to layout and drill a four-family apartment in 8 hours (about 145 holes). This job formerly took 36 hours." Mr. Haeussler concludes with: "I actually bought my third Wood Borer particularly for a job I knew would be finished in less than three months."

In your electrical work, you too, can show similar savings. The "Tall Reach" Wood Borer can be equipped with bits for wood, metallic, masonry or composition work. Write for folder F showing details or see the KETT Wood Borer at your dealer, or authorize C. O. D. shipment, price $139.50 (11/16" bit, $1.75 additional).

** Actual letter available on request.*

THE KETT TOOL COMPANY
5 E. THIRD ST., CINCINNATI 2, O.

Committee of the Illuminating Engineering Society, and was chairman of the IES subcommittee which prepared the Recommended Practice of Home Lighting. She has also served as chairman of the Chicago and New York Residence Lighting Forums of the IES, and has written many articles.

"Residential Lighting" is published by the D. Van Nostrand Company, Inc., New York, and is available at most bookstores and from the Advertising and Sales Promotion Department, Westinghouse Lamp Division, Bloomfield, N. J. The price is $10.00.

DATES AHEAD

International Association of Electrical Inspectors — Western Section, Mount Royal Hotel, Montreal, Quebec, Canada, October 13-15; Eastern Section, Seaside Hotel, Atlantic City, N. J., October 20-22, Southern Section, Hotel George Washington, Jacksonville, Fla., October 27-29.

International Municipal Signal Association, Inc.—Annual meeting, Pantlind Hotel, Grand Rapids, Mich., September 29-October 2.

National Safety Congress & Exposition—Chicago, Ill., October 6-10.

First Annual Cold Cathode Fluorescent Lighting Exhibit—Hotel Commodore, New York, N. Y., October 7-9.

National Farm Electrification Conference—Claypool Hotel, Indianapolis, Ind., October 7-8.

International Association of Electrical Leagues — 12th Annual Conference, Statler Hotel, St. Louis, Mo., Oct. 8-11.

American Standards Association—Annual meeting, Waldorf-Astoria Hotel, New York, N. Y., October 21-23.

National Electrical Manufacturers Association—Traymore Hotel, Atlantic City, N. J., Week of Oct. 26.

National Electronic Conference—Edgewater Beach Hotel, Chicago, Ill., November 3-5.

American Institute of Electrical Engineers—Midwest meeting, Chicago, Ill., November 3-7.

2nd International Lighting Exposition—Hotel Stevens, Chicago, Ill., Nov. 3-7.

National Metal Trades Association—Palmer House, Chicago, Ill., November 6-17.

National Association of Manufacturers—Waldorf-Astoria Hotel, New York, N. Y., December 3-5.

Fifth All Industry Refrigeration and Air Conditioning Exposition—Public Auditorium, Cleveland, Ohio, January 26-29.

American Institute of Electrical Engineers—Winter general meeting, William Penn Hotel, Pittsburgh, Pa., January 26-30.

8th International Heating and Ventilating Exposition—Air Conditioning Exposition, Grand Central Palace, New York, N. Y., February 2-6.

National Electrical Manufacturers Association—Winter Convention, Edgewater Beach Hotel, Chicago, Ill., March 14-18.

Chamber of Commerce—Annual meeting, Washington, D. C., April 27-29.

National Electrical Wholesalers Association—Annual convention, Statler Hotel, Buffalo, N. Y. First week in May.

MANUFACTURERS NEWS

GENERAL ELECTRIC CHANGES

Robert P. Allison, Jr., has been appointed manager of manufacturing of the General Electric Company's wire and cable division, Bridgeport, Conn., succeeding S. T. Powell, who has re-

tired from the company after 39 years' service.

Mr. Allison is in turn succeeded as manager of G. E.'s Marginal Street Works in Lowell, Mass., by Howard J. Stewart, formerly assistant manager of the works.

C. B. Davidson has been named southeastern district manager of construction materials, with offices in Atlanta, Ga.

James R. Hitchcock has been appointed representative in the southwest for G-E wiring devices, accessory equipment, wire and cable and conduit products. He will cover the Amarillo, Little Rock, Oklahoma City and Tulsa areas.

Announcement has been made of the appointment of W. S. Ginn as assistant manager sales in G-E's power transformer section, Transformer Division.

Z. G. Taylor has been promoted to the position of assistant manager of Lamp Manufacturing Division of G-E's Lamp Department, Nela Park, Cleveland and H. F. DeLong has been elevated to position of manager of the department's East Cleveland Lamp Works. Mr. Taylor, who has been manager of the East Cleveland Lamp Works for the past four years, succeeds G. E. Burens, who recently joined Telechron, Inc. to serve as vice president in charge of manufacturing.

John F. McClenahen has been promoted to manager Standardizing Division of the Lamp Department at Nela Park. He succeeds Raymond B. Walling, who retired after serving as manager of the division since 1936.

ALLEN-BRADLEY OFFICERS

At a recent meeting of the board of directors, Fred F. Loock, formerly vice president and general manager, was elected president of the Allen-Bradley Company. Harry L. Bradley was named chairman of the board, in which capacity he will continue to be active in the corporate direction of the Company.

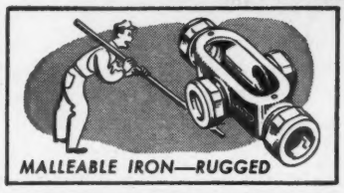
Other officers, who were re-elected, are R. W. Whitmore, vice president and works manager; Louis Quarles, secretary; and A. F. North, treasurer.

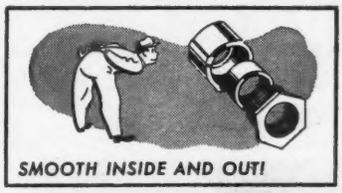
AMERICAN STEEL & WIRE APPOINTMENTS

Four personnel appointments in the sales department of Cyclone Fence Division of American Steel & Wire Co. have been announced.

E. Kyndberg has been made general sales manager with headquarters at Cyclone's main office at Waukegan, Ill. J. F. Boyce has been appointed district sales manager at Waukegan, while R. W. Ewart has been made district sales manager of the southeastern district. J. D. Filer has been promoted to the position of assistant district sales manager of the eastern district.

They make tough jobs easy because GEDNEY FITTINGS...FIT!


MALLEABLE IRON—RUGGED


SMOOTH INSIDE AND OUT!

BRIGHT FINISH— RUST PROOF

THREADS CLEAN—EASY TURNING

EASY TO INSTALL

A COMPLETE LINE

GOOD WIRING DEPENDS ON FITTINGS THAT ARE RIGHT FOR THE JOB!

What electricians and contractors want most in the fittings they use is smooth fit. They want conduit to thread in smoothly, caps to fit into place easily, screws to align and tighten evenly. With GEDNEY fittings the contractor knows his job will come out right. All GEDNEY fittings are packed in sturdy, metal-edged boxes that can't break open, and each package is clearly labeled for quick selection.

The fact that GEDNEY fittings have been on the "best seller" list with mechanics who know fine accessories is proof enough of year in—year out excellence. Check the other features in the panel at left. They highlight the points about GEDNEY fittings that mean money in the bank for "live wire" wiring men.

ASK YOUR WHOLESALER

WRITE FOR LITERATURE

GEDNEY ELECTRIC CO.
FOUNDRY, FACTORY & SHIPPING POINT: TERRYVILLE, CONN.
RKO BLDG., RADIO CITY, NEW YORK 20, N. Y.

Bend Conduit Cold-

Here's How

Conduit can be bent

40°

to any desired angle

60°

without moving pipe

90°

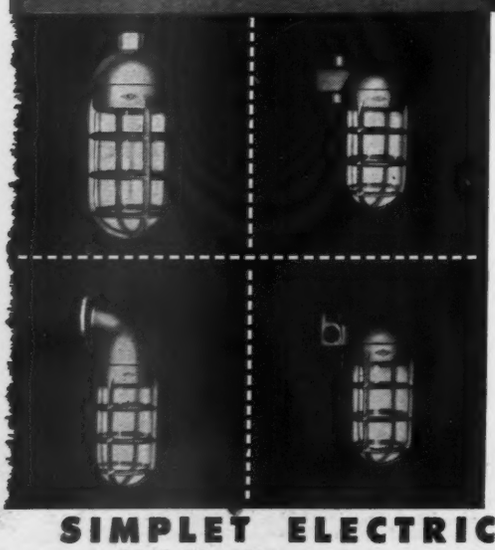
in one operation

...more smoke operation with Tal's Prestal Pipe Bender

Installation work goes faster, easier, and at a lower cost when you have a Tal's Prestal Bender on the job. This efficient, light, portable machine handles all pipe and conduit up to 3". Makes perfect bends, up to 90°, cold, in one single operation. No need to waste labor by replacing the pipe three to six times to make a bend. Does a good workmanlike job — smooth, uniform bends without kinks or wrinkles. Simple and easy to operate. Thousands are in successful use everywhere. Write for data bulletin.

Tal Prestal Bender, Inc.

Dept. EC-10, Milwaukee 2, Wisconsin



The SIMPLET Line of Vaportite Fixtures and Fittings has been carefully designed to permit universal application.

There are 28 types and sizes of fixtures each of which is furnished for either ½" or ¾" conduit. Developed through many years of experience in this specialized field, Vaportites will exceed the most rigid specifications encountered on the toughest of jobs where perfect sealing is essential.

Write today for descriptive information and prices.

SIMPLET ELECTRIC COMPANY

3600 West Potomac Avenue • Chicago 51, Illinois
112 Charlton Street • New York 14, N. Y.

WESTINGHOUSE APPOINTMENTS

H. W. Lingenfelter, for 23 years a lighting engineer with the Westinghouse Electric Corporation, has been appointed manager of commercial, industrial and floodlighting sales for the Lighting Division in Cleveland, Ohio.

The appointment of P. T. Lagrone, manager, Customer Section, Central Station Sales Department, East Pittsburgh, has been announced.

Dr. R. C. Mason has been named manager of the Electro-Physics Department of the Westinghouse Research Laboratories, succeeding Gaylord W. Penney, who was recently appointed Westinghouse Professor of Electrical Engineering at the Carnegie Institute of Technology.

THOMAS TO SUCCEED GREGORY AT FIBERGLASS

John H. Thomas will succeed George E. Gregory as vice president and purchasing director of Owens-Corning Fiberglas Corporation, and Ben S. Wright will become Owens-Corning's General sales manager.

Mr. Gregory has resigned from Owens-Corning to become president of the Morton-Gregory Company, Inc., a new organization being formed to manufacture and sell new industrial and consumer products calling for large scale use of Fiberglas yarns.

The new products to be manufactured by the Morton-Gregory Company were developed by a group headed by Henry J. Morton, Detroit consulting electrical engineer and president of H. J. Morton and Associates, Inc. Manufacturing, it is reported, is planned to get under way within six months.

PENFLEX APPOINTMENTS

The appointment of H. L. Boetsch as vice president in charge of sales of Pennsylvania Flexible Metallic Tubing Company, Philadelphia, has been announced.

T. R. Boyle, formerly manager of the Syracuse branch, has been named manager of the Chicago branch located at 4532 W. Harrison Street. J. J. Lynch has been appointed manager of the Syracuse branch to succeed Mr. Boyle.

TELECHRON APPOINTMENTS

Telechron Inc. of Ashland, Mass. has announced the appointment of A. F. Fisher as executive vice president. Since October, 1945, Mr. Fisher has been vice president in charge of manufacturing and engineering.

Harold E. Blackburn has been named field sales manager. This is a newly created post and he will be in charge of the operation of Telechron's field sales force.

PYLE-NATIONAL ELECTIONS

Carl Geis and T. E. McDowell have been elected vice presidents of the Pyle-National Company, Chicago.

Mr. Geis has been placed in charge of sales, and he was formerly eastern sales manager with headquarters in New York City. Mr. McDowell has been placed in charge of engineering.

•

R. I. Insulated Wire Company, Inc. of Providence, recently appointed Marwood, Limited, of San Francisco, as Pacific Coast managers for its complete wire and cable line; and Ellman & Zuckerman of Chicago as representatives in that territory to handle its flexible cords line. Crescent Electric Sales Company of Chicago will be retained to handle the asbestos insulated wire products.

•

Faraday Electric Corporation, Adrian, Mich., has announced the appointment of F. B. Fisher as assistant sales manager, replacing C. L. Hobbs, who returned to Chicago as branch manager of the Faraday sales office.

•

According to an announcement made jointly by Milton M. Morse, president of **Modern Controls, Inc.,** 176 West Adams Street, Chicago, Ill., and Harold E. Koch, president of **Hevi Duty Electric Company,** Milwaukee, Wis., a contract has been entered into between the two companies under which production of the Haug type constant current regulator will be undertaken exclusively by Hevi Duty. Sales will be handled by both companies.

•

The Industrial Electronics Corporation, Newark, N. J. has begun the manufacture of fluorescent tubes according to a statement by Bert R. Joel, executive vice president of the company. The current output will consist of fluorescent tubes of various sizes and color, and will be distributed in the domestic market only.

•

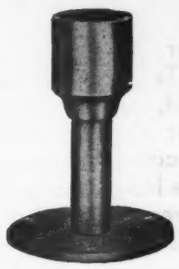
D. J. Chapman has been appointed Michigan representative for the **Essex Wire Corporation** of Fort Wayne, Ind. He will cover the entire state, maintaining headquarters at 14310 Woodward Ave., Detroit, Mich.

•

Carl C. Langevin has become a member of the board of directors of **The W. L. Maxson Corp.,** of New York. The Maxson Corporation has recently acquired all of the common stock of a newly organized **Langevin Manufacturing Corp.,** also of New York, of which Mr. Langevin is president.

FULLMAN Latrobe PRODUCTS

FLOOR BOXES ★ WIRING SPECIALTIES

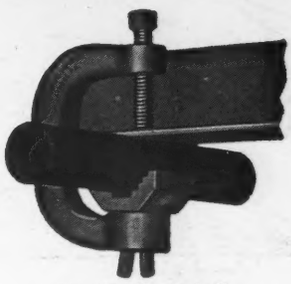


No. 280 Nozzle with No. 200 Cover Plate

10 Amp. 250 Volt Receptacle in Brass Housing, mounted on ½" brass pipe extension 3" long—longer extension if desired.

"Bull Dog" Insulator Support

"Bull Dog" Supports are safe and efficient for fastening porcelain or glass insulators to exposed steel framework. Four sizes, from 1" to 2½".



No. 470 "Latrobe" Pipe or Conduit Hanger

Of highest grade malleable iron, and cadmium plated, the No. 470 is unexcelled for hanging ½", ¾" and 1" pipe or conduit to steel beams up to ⅝" thick.

"LATROBE" PRODUCTS SERVE LONG AND WELL

You will save time, money and worry by installing "Latrobe" products. Years of actual use in every section of the United States have earned impressive leadership for "Latrobe" floor boxes and wiring specialties.

No. 150 Box No. 207 Nozzle

Adjustable and watertight for installation in concrete or wood-finished concrete floors. Furnished with a 4¼" Cover Plate No. 242 and large Adjustable Ring No. 215.

"Bull Dog" BX Cable Staples

Millions of these high quality, dependable staples are now in use. Packed in cartons, kegs or barrels.

No. 110 "Latrobe" Watertight Box

This non-adjustable, watertight box is extremely simple in design, making for speedy installation and trouble-free service. 208 Receptacle. Cover plate 3½" diameter.

Sold only through wholesalers

No. 284 Nozzle with No. 200 Cover Plate

Neat, compact-fitting, and extremely durable, this Duplex Receptacle Nozzle is furnished with either ½" or ¾" brass pipe extension.

No. 252-R Two Gang Box

This Two Gang Adjustable Box has our own No. 208 Receptacle in one section. One cover plate has ½" Flush Brass Plug; other has 2" Flush Brass Plug.

FULLMAN MANUFACTURING CO.
LATROBE . . . PENNSYLVANIA

POWERS VOLTESTER

CATALOG NO. E 112

Is a practical tool for ordinary voltage testing. It is equipped with a six-watt Mazda lamp (not a neon lamp) which will tell you positively at a glance whether the circuit is HOT and HOW HOT.

You should know if you are working on 110-220-440 or 550 volts. A POWERS VOLTESTER tells you definitely. You need no light to read the voltage shown with this tester. It tells you by the brilliancy of its own light what voltage you are on.

If you must know the exact voltage reading use a Volt Meter. But for practical testing use a POWERS VOLTESTER.

Sold Only Through Distributors

LIST PRICE WITHOUT LEATHER CASE.....5.20

LIST PRICE WITH LEATHER CASE (Attachable to belt).....6.60

MADE BY **POWERS MFG. CO.** 1527 FOLSON ST. SAN FRANCISCO 3, CAL.

● They sure are big! Superior makes plenty of big brushes for motor generators, cranes, diesel engines, mine locomotives, steel mills, and other heavy duty jobs. We enjoy putting into them, from more than 28 years' experience, the kind of thought and materials that will enable them to furnish you long, worry-free service. At your service!

Superior Industrial Carbon Brushes are prescribed, not catalogued.

SUPERIOR CARBON PRODUCTS, INC.
9113 George Avenue • Cleveland 5, Ohio

"Since 1919" SUPERIOR CARBON BRUSHES

S&C Electric Company, Chicago, formerly Schweitzer & Conrad, Inc. has leased another manufacturing building in the neighborhood, which will be known as Plant No. 2, for the manufacture of distribution primary cutouts, and a considerable increase in storage facilities at Plant No. 1.

•

The appointment of Rudolf Feldt as head of the Cathode-Ray Oscillograph Manufacturing Department with headquarters in the Clifton plant, has been announced by **Allen B. DuMont Laboratories, Inc.,** Passaic, N. J.

•

Cutler-Hammer, Inc. has moved its Cleveland sales office to new quarters at 2010 East 46th Street. R. J. Eckstein is Cleveland district sales manager.

•

Interstate Manufacturing Corporation with offices at 138 Sussex Avenue, Newark, N. J. recently completed and are now occupying their new plant at 32–36 Newark St., Newark. Executive offices will still be maintained at 138 Sussex Avenue.

•

The Cabl-Ox Corporation, 6 North Michigan Avenue, Chicago, Ill. has been formed to manufacture Cabl-Ox wire rope clamp, Cabl-vise and allied wire rope products.

•

T. J. Cope, Inc., of Philadelphia has named Charles E. Adams as its agent covering the Western Pennsylvania and West Virginia territories. His offices are located at 208 Kirby Bldg., Pittsburgh, Pa.

•

Arthur Koehler has been appointed production manager of **Sorensen & Company,** Inc., Stamford, Conn.

•

Acme Electric Corporation, Cuba, N. Y. announces the appointment of Edward A. Miller as vice president in charge of engineering.

•

The Buda Company has named Harry G. Campbell as sales manager of the DieseLight Division, Harvey, Ill.

•

The Johnson Bronze Company, New Castle, Pa. has opened a new sales office at 1513 Guilford Avenue and a warehouse at 1044-46 Broadway, Denver, Colo.

NECA CONVENTION REPORT

[FROM PAGE 49]

and aggressive sales development and business promotion.

The expansion of electrical use is the primary and fundamental production problem of the electrical industry and the industry has the solution in its hands, N. J. MacDonald, chairman of the Interdependence Committee of NEMA and vice president of Thomas & Betts Company declared.

The solution lies in the insistent and constant application of the Electrical Interdependence program in all branches of the electrical industry. He indicated that important steps in executing this broad industry-wide public relations and business promotion program are being taken.

It is a practical lesson in productivity, teaching the necessity for all to produce and the necessity of all to sell so that production can be maintained and expanded. Cooperation of the electrical employee is asked for his self interest which is job security. Cooperation of management is based on management's self interest which is business security.

Electrical Interdependence is effort for, by and of the electrical industry, Mr. MacDonald said. For the industry's good. For the public good. For your own good. It depends on only one thing. Good old self interest.

Laurence W. Davis, executive secretary and treasurer of the National Electrical Benefit Fund reported that organization of the machinery to carry out the Employees Benefit Agreement is proceeding rapidly. There are 56 local boards in operation. Total payroll collections from contractors the first month were $11,964; for June the sum had risen to $37,580 and in July the collections were $52,771. On August 1 there were 3,109 members of the union on the pension rolls. New pensioners are being added at the rate of 400 a year. The present pension list requires $1,860,000 annually.

NECA and IBEW, which set up this practical method of voluntary arbitration a generation ago, have come a long way on the road to good management-labor relations, declared M. L. Ratcliff, business manager, Local Union No. 569 IBEW; member of Council on Industrial Relations. We still have a long way to go before a perfect set-up is made. But with the same cooperative spirit being shown in the future as I have experienced during my term on the Council, I can assure you of success for both organizations.

...and get these important advantages

- Proper types for all applications.
- Operated by precision Telechron* motors.
- Expert assistance in application problems, backed by years of experience.
- Convenient sales and service facilities.

FOR LIGHTING CONTROL—TYPE T-27

Wide adaptability, low-cost installation and maintenance make the T-27 (shown above) suitable for all general-purpose applications.

Completely automatic control requiring no manual adjustment after initial setting.

Simple design, meaning fewer parts to wear—fewer places for trouble.

Easy to handle—hinged cover, plenty of wiring space, five standard knockouts for conduits.

**Reg. U.S. Pat. Off.*

LIGHTING JOBS THE T-27 CAN HANDLE

Spectacular sign displays
Street lighting circuits
Floodlighting of construction projects and amusement areas
Floodlighting of buildings and monuments
Store- and show-window lighting for after-dark displays
Electric signs and billboards
Airport lighting
All-night lighting in apartment houses

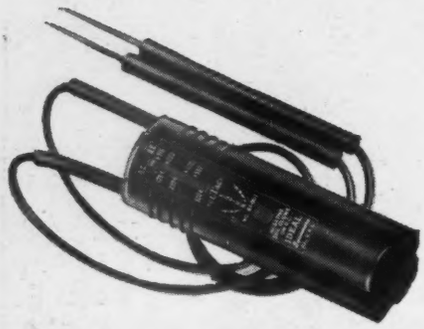
An astronomic dial is available for dusk-dawn schedules—particularly popular for illumination of signs, billboards, and street lights. An omitting device can be furnished for omitting operation on any desired days of the week. For further information, call your nearest G-E apparatus office, distributor, or agency, or write for Bulletin GEA-3339. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

603-40

ELECTRICIANS
MAINTENANCE MEN
CONTRACTORS
RADIO SERVICE MEN

YOU NEED THIS NEW*
IDEAL Voltage Tester



*NOT an ordinary "glo" type
—actually indicates voltages

Here it is—a real voltage tester that accurately indicates the nominal line voltage on an easy-to-read calibrated scale. Combines a solenoid voltage indicator *and* a neon test lamp for *double protection.*

FOR TESTING...

Continuity of Circuits (AC or DC)
110 to 550 v. AC
110 to 600 v. DC

Blown Fuses

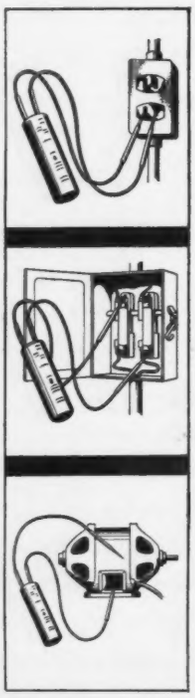
Grounded Side of Line, Motor or Appliance

Excessive Leakage

Frequency (25 or 60 cycle)

DC Polarity

Safe . . . easy and convenient to use ...sturdy...compact . . . built for lasting service. Test prods and leads are amply insulated. Light weight unit encased in easily-held, streamlined plastic case.



Write for New Bulletin Today!

IDEAL INDUSTRIES, INC.
(Successor to Ideal Commutator Dresser Co.)
1041 PARK AVENUE, SYCAMORE, ILLINOIS

IDEAL
Distributed Through
AMERICA'S LEADING WHOLESALERS
Canadian Distributor: Irving Smith, Ltd., Montreal

"The Progress of the Apprenticeship and Training Program in the Electrical Contracting Industry" was discussed by E. H. Herzberg, chairman, National Joint Apprenticeship and Training Committee. He announced that the outstanding apprentice in the electrical industry in the United States will be selected next year and each succeeding year and will be given a national award at the annual meeting of NECA. A procedure for selection of the winner has been worked out between management and labor which share jointly the responsibility for training new men.

Mr. Herzberg reported that there are 6,069 employers participating in the 320 local joint apprenticeship and training committees in the industry.

The Line Constructors Division met Tuesday night with C. W. Mosely, R. H. Bouligny, Inc. presiding.

J. K. O'Shaughnessey, chief of the engineering division of the Rural Electrification Administration, said that the greatest need of the REA program now and in the year ahead is electrical contractors who will bid competitively and who are qualified to perform.

Don't get the idea that either the cooperatives or REA are sold on the labor only contract, he said. We expect to get away from it just as soon as it is possible to do so and right now we are working on a procedure to change from a labor only contract to a contract for labor and materials on future projects. The transition will be slow and difficult but it will be accomplished.

At the Wednesday morning session with Robert W. McChesney presiding, there was a discussion on production problems led by Charles A. Langlais, Charles A. Langlais Co., San Francisco; Oliver F. Burnet, Jr., Kelso-Burnett Electric Co., Chicago and A. Herrmann Wilson, Electrical Construction Co., Inc., Washington.

Paul M. Geary, executive vice president, NECA, discussed the various conditions of the Taft-Hartley law.

J. Walter Collins, manager, Chicago and Cook County Chapter, NECA talked about the "High Cost of Installation-Only". Labor only is an uneconomical way of doing business. It gives split authority on job control and increases costs.

In addition to the resolutions already mentioned, the convention opposed the principle of vacations with pay on the basis that it would be disruptive to productivity.

Robert W. McChesney was re-elected president.

CUT COSTS
ON SOLDERING AND BRAZING

NEW IDEAL
"THERMO-GRIP"
SOLDERING SET

Here you see one of the many money-saving applications of the Ideal "Thermo-Grip". In this view, a broken joint in a machine tool hydraulic unit is being easily and quickly resoldered. Hundreds of industrial plants are using Ideal "Thermo-Grips" for faster, safer, better soldering—with less waste of parts and materials.

This new light weight, portable unit operates on the resistance heating principle—grips work while heating. Concentrates heat on the spot to be soldered, conserves power. Handy thumb switch permits close control . . . all parts fully insulated—no fire or shock hazard. Any one can use it with complete safety and expert results.

Write for full details at once!

ATTACHMENTS for All Types of Soldering Jobs—"Plier" ..."Pencil"..."Fork"

IDEAL INDUSTRIES, Inc.
Successor to Ideal Commutator Dresser Co.
PARK AVE.,
SYCAMORE, ILLINOIS

IDEAL

DISTRIBUTED THROUGH
AMERICA'S LEADING WHOLESALERS

ESCALATOR INSTALLATION

[FROM PAGE 51]

business, fire, maintenance or repair) two independently operating friction clutch brakes bring each escalator to a rapid, positive, smooth stop. Separate magnets hold these brakes out of service as long as operation is normal but any interruption of power, caused by manual stop buttons, safety switches or speed governor, releases the brakes several seconds apart so that, whether the escalator is empty or filled, stoppage will be smooth yet definite. Since brakes are tested at least once a day when escalators are stopped after business hours, there is no doubt concerning positive operation in an emergency.

With the exception of the driving machine and controller, all essential parts of the escalator are supported either within or on top of the structural steel truss that forms the basic framework of each run or flight. The lower carriage, contained inside the framework at the bottom landing, consists of a floating set of semi-circular cold-rolled steel tracks around which the steps rotate to reverse direction. Straight inclined tracks carry the moving steps between top and bottom landings. At the upper end of the truss is located the main drive assembly. The handrail system and the handrail drive mechanism are mounted on top of the frame. The handrail system is enclosed by a metal housing or balustrade that combines simplicity and beauty of design with such functional qualities as rigidity, surface smoothness and resistance to scratching or abrasion.

A new feature of the modern postwar controller is an indicator system that instantly registers the exact source of any safety-induced stoppage, thus eliminating the necessity for tracing the source and cause of trouble. Safety switches are activated by speed governors that stop the escalator in the event of either overspeed, underspeed or an unintentional reversal of direction; by the release of tension on the handrail; by handrail limit switches when the part-rubber handrails stretch to the point where shortening is required; or by a lower carriage safety device that operates in case of a break in the step chain.

Still another safety feature is the shutter assembly that acts as a fire stop to seal the escalator, the flexible metal shutter being similar to a roll-top desk in both construction and operation, and operated by four methods. The new

40 Years' experience plus modern design is built into every R&S product.

R&S reflector contours are scientifically designed with high reflection factor providing a maximum of safe controlled light at minimum cost.

Thorough inspection and rigid factory controls insure longer life and low maintenance.

R&S explosion-proof lighting fixtures are supplied with a standardized base common to all sizes. Reflector globe assemblies of various capacities are interchangeable to suit conditions. No need to disturb mounting or electrical connections. Modern design simplifies mounting and affords a variety of conduit arrangements in one standard base. Installation costs are lower, parts fewer and ordering easier.

In hazardous areas, you can't afford to experiment. R&S explosion-proof and vaportight lighting fixtures are precision built and pass the rigid tests of Underwriters' Laboratories.

Specify R&S and be sure. Write for our catalog. You will find it valuable in planning new work and bettering existing installations to meet tomorrow's standards.

Sold through Electrical Jobbers

Sales Representatives in Principal Cities

Please address Dept. No. 4 36

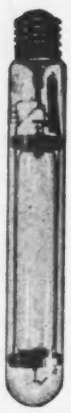
SINCE 1902

RUSSELL & STOLL COMPANY, INC.

Precision-Built Electrical Equipment

125 BARCLAY STREET, NEW YORK 7, N. Y.

GOODRICH
TWIN HIGHLITE
for
mercury vapor illumination



Where work calls for the best in high bay illumination, the Goodrich Twin Highlite is the wise selection.

Combining two Highlite Reflectors on a channel for single suspension, this fixture delivers uniform high intensity illumination over wide industrial interiors with perfect diffusion and minimum glare. It assures constant good vision and relief from eyestrain.

The Twin Highlite is finished in permanent porcelain enamel; available with dust-tight glass lens. Furnished for twin-mercury, or mercury-incandescent combination. Write for literature.

Sold through Electrical Wholesalers

APPLETON ELECTRIC COMPANY
1704 Wellington Ave. • Chicago 13, Ill.
14 Branch Offices and 7 Resident Representatives in All Principal Markets

RLM

APPLETON
CONDUIT FITTINGS • OUTLET AND SWITCH BOXES • EXPLOSION-PROOF FITTINGS • REELITES

Kresge escalators are the first units to be installed with shutters controlled automatically by smoke-detecting photo-electric light sources or by thermostatic elements located in each escalator well. Photoelectric beams, passing above the heads of passengers, cross and recross each stairway, following a mirror-reflected path. Should a haze of smoke interrupt the beam for a continuous 15-second period, or should the temperature in the well exceed a predetermined limit, the fractional horsepower shutter motors would be started and escalator drive motors stopped. A third method for starting the shutter motor is by a manually operated and conveniently located pressure switch. In the remote event that all electrical methods should fail simultaneously, a hand crank is provided for manually rolling the shutter over the hatch. Shutters operate at the relatively slow speed of 30 feet a minute so that passengers have ample time to walk either up or down the stopped escalator and still pass the fire barrier before it completely closes. The leading edge of the shutter is sensitized so that, should the closing shutter touch a passenger, it would stop until the passenger had moved to safety.

Maintenance of the Kresge escalators is by the personnel of the engineering department, under the supervision of Edward B. Ledden, chief engineer. Maintenance is comprehensive and includes both electrical and mechanical adjustments, minor repairs and replacement of parts, cleaning and lubrication of equipment. In several cases, maintenance of the escalators is supervisory rather than manual since new design features reduce maintenance routines to a minimum.

Above and around each pair of escalators, a furred canopy is suspended 4 feet beneath the ceiling levels. Perimeter lighting is provided around this canopy by two continuous rows of 20-watt and 40-watt white fluorescent lamps mounted end to end with sockets staggered to prevent dark spots. Lamps, mounted 3¼ inches apart vertically, and shielded by continuous plywood facia, direct light upwards to the ceiling, downwards through louvred troughs to the floor area, and outwards through cutout translucent direction signs.

Incandescent 200-watt downlights, behind square Controlen plates, are recessed into the suspended canopies to build up the footcandle level at escalator landings. Lighting is connected to two separate panels, half the perimeter lighting and half of downlights being circuited to each panel.

VOLUME DURATION STUDIES

[FROM PAGE 54]

manpower would be from outside his regular organization.

It would take an average of 8.5 men to complete the project in 19 weeks. A contractor who could furnish only an average of 5 men would need $\left(\frac{8.5}{5} \times 19\right)$ 33 weeks to complete the work. Suppose the time were extended 20 percent longer than the estimated optimum time of 19 weeks. The resultant time would be approximately 23 weeks. For a 23-week period, the average number of mechanics needed would be $\left(\frac{19}{23} \times 8.5\right)$ seven. This would still be 40 percent more men than the contractor could normally provide.

Granting that the duration period was long enough to permit mustering the average manpower, there would still be the peak demand to consider. Table II shows the peak demand for 19 weeks to be 15 men. Then, for 23 weeks the demand would be at least 12 men $\left(\frac{19}{23} \times 15 = 12.4\right)$ But the $150,000 contractor only averages 10 or 11 men. Again he would need some unusual breaks to carry the work on at all successfully. The following table shows the optimum duration requirements of a $50,000 project compared to the normal capacity of a contractor having an average (3 year) annual volume of $150,000.

	$50,000 Project Req. for Optimum Duration	Normal Cap. of Contr. ($150,000 Vol.)
Duration of Contract	19 weeks	23 weeks
Average No. of Mechanics	8.5	7
Maximum No. of Mechanics	15	12

In addition to manpower problems, the possibilities of being able to provide engineering, supervision, tools and equipment, as well as general administrative services, have to be considered. Mechanics can show a high rate of productivity only when they have the proper support, and are provided with adequate tools and equipment.

From the foregoing it is evident that any contractor contemplating a contract which exceeds one third his annual volume, must analyze his possibilities carefully.

A future article on "Costs of Extended Duration" will elaborate on this phase of estimating.

YOU HAVE HEARD THE EXPRESSION:

"Cold as a BRASS MONKEY"

WELL...

Monarch Renewable Fuses

ARE NOT THAT COLD...

They are Famous for

BETTER HEAT DISSIPATION

because

They are Built with an Adequate Amount of

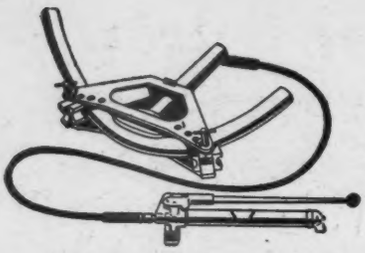
BRASS

A Complete Line of Knife Blade & Ferrule Types Gives You... FUSErvice You Can Depend Upon

AVAILABLE THROUGH RECOGNIZED WHOLESALERS

MONARCH FUSE CO., LTD.

118 E. FIRST ST. JAMESTOWN, N. Y.



When you buy a

BENDER

..check to make sure you get these features:

EASY TO GET TO THE JOB

☑ Lightweight, portable—one man can easily take a Blackhawk Pipe Bender right to the job. Bends rigid conduit and pipe in all popular sizes, up to 4" dia.

WORKS AT ALL ANGLES

☑ The compact hydraulic Porto-Power Ram is all-directional. Power eliminates need for heating the pipe.

WORK OVERHEAD

☑ All-directional operation and light weight enlarges range of utility to use on ladders, scaffolds and cramped quarters and work on existing pipe runs.

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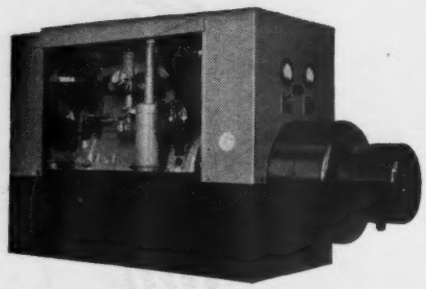

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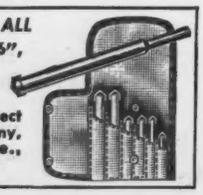

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